RAILWAY ENGINEERING AND MAINTENANCE OF WAY.

BRIDGES · BUILDINGS · CONTRACTING · SIGNALING · TRACK.

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Bush and Gunpowder River Bridges.

THERE ARE a good many features of interest in the article on the Bush and Gunpowder River bridges, on another page of this issue.

The concrete used in the footing slab was richer than that in pier bodies, and this is accounted for by the fact that the footings were placed under water. The coarse aggregate for floor slabs was crushed stone, passing a one-inch screen, while all other aggregate was washed gravel. This illustrates the fact that no precautions were overlooked in design or construction which would increase the strength of the concrete in the reinforced slabs.

The use of reinforced concrete bridge floor slabs is particularly adapted to structures of this type, where the bottom is soft and the foundation rests on piles, and where the bridge is long and low.

The engineering and surveying was all done with the idea of prevention rather than correction. Precautions that might appear ridiculous to the layman were insisted on by the engineer in charge with the result that no instrumental mistakes of importance were made in the entire structure. When setting pier points from base line on the old bridge, by turning off the angles, two men were needed with the transit, one using the instrument, the other watching for trains. Each man was required to set each point, checking by throwing the instrument out of line, readjusting and resetting the point, not by checking the point formerly set. This was the means of detecting several errors.

After the piers were set, sighting points were established on the opposite sides of the old bridges, by sighting across which it could be readily determined if the forms were far off. This feature was the means of detecting a pier form which had been knocked off center by some floating object during the night.

Another precaution was as follows: As soon as the plumb piles were all driven in a pier, the inspector was required to row over to the old bridge opposite, and cut a cross in the walk. When the batter piles were driven he was required to cut a second cross. As these piles were under water, these indications were of great value throughout the work.

A very effective plan was used for determining depth of pile penetration when driving. The piles were all cut to proper length to give the desired penetration, and so that they would stick up 2 ft. into the footings. A gage was rigged up on the leads of each pile driver, with a movable marker, the latter being placed at the proper mark for top of follower. Water gages were located on the old bridge, and the marker was adjusted as necessary, as the height of water changed.

Exhibits, Permanent and Temporary.

RAILWAY SUPPLY and equipment concerns have each year appropriated greater sums for the purpose of exhibiting their product to purchasers, until present expenditure for temporary exhibits is scarcely realized by those who view them and are educated thereby. Temporary exhibits at conventions, while a necessity, are very expensive and in the fact that, in spite of the expense, the exhibits still grow in volume, lies the argument of those who urge the permanent exhibit.

In the machinery field there has been maintained a permanent

exhibit in the city of Philadelphia. The "Bourse" is an institution of long standing and has reached a degree of success which seems to warrant permanency. The only institution of like nature in the railway field is the "Railway Supply Permanent Exhibit" in the Karpen building, Chicago. This is an institution of comparatively recent inception, but its growth and popularity among those who have benefited by its system seems also to confirm the opinion that the permanent exhibit is a modern need. It does not of necessity form a substitute for convention exhibits except when such conventions are held in the immediate neighborhood, but the argument for convention exhibiting applies in reinforced effect with respect to the permanent exhibit.

Railway officers are not attracted in great numbers to the permanent exhibit at any particular period, but during the course of the year the number of visitors is perhaps as large as at any convention, while there is the advantage to exhibitors that those who do come are brought by the desire of educating themselves by inspection of the appliances solely. The attraction to the exhibit is magnified by the club facilities in connection and proper management cannot fail but make the permanent exhibit permanent.

Twenty Years Ago This Month.

WITH THIS issue we incorporate a feature which we believe will interest the young as well as the older officers of the engineering departments. The important events of twenty years ago in railway work form history, the perusal of which is instructive as well as of momentary interest. The problems of that date and the methods of their solution have direct application in the solving of modern problems.

Many of the men now engaged in active work were then in precisely the same field of activity. But the larger number of present day engineering officers have since arrived. Some look upon twenty years as a short period indeed and in some lines of slow development there has been little change. However, the development in most lines of endeavor has been so great as to be realized only by scrutiny of the records of twenty years.

This column will be as interesting in the future as our readers make it, and the editors expect the assistance of those with good memories in securing the items of greatest importance and interest.

Rail Creeping.

On another page of this issue we print an article on rail creeping, from a subscriber in India. Aside from the interest which should attach to this communication from the other side of the world, the enumeration of causes of rail creep is most interesting and complete. Some of the suggestions for remedying the trouble are so entirely foreign to American practice as to be of decided interest.

Correction.

In the June issue of *Railway Engineering*, the location of the new Baltimore & Ohio R. R. treating plant was given as Green Springs, Virginia. This plant is located at Green Springs, West Virginia.

Aliquippa Interlocking.

THERE ARE several interesting features in the Aliquippa interlocking, one of more than ordinary interest being the use of an auxiliary train order signal, located on the home signal mast on the opposite side of the pole from the interlocking blades.

The advantages of this combination are apparent. The engineman obtains at a glance at the signals on one mast, all the information necessary to tell him whether to proceed or stop. In addition to this, no extra mast is required for the train order signals, and there will be no confliction of two signals in different locations.

When the train order signals are on separate masts, or located at the tower, the engineman might possibly receive a clear indication at the home signal, and a stop indication at the tower or train order signal.

Another feature, indicating the practice on the P. & L. E. R. R., is the absence of derails at main line signals. There are only two derails in the entire plant, and these are located on a freight lead to be used by long drags, where there is danger that, even after the engine has stopped, the slack in the train may be sufficient to let the last car overrun the signal.

The original combination of the train order signal on the home signal mast appears to be a feature that could be profitably adopted in many interlocking plants.

USE OF COMPRESSED AIR FOR FORCING PRESERVATIVE INTO TIMBER.

Editor *Railway Engineering:*

I have your favor of the 25th inst., and would say in reply that information referred to is correct. The Green Spring Plant of the B. & O. R. R. was not the first to use air pressure for forcing preservatives into woods.

The idea was conceived by me in the year 1909, submitted to the management and necessary equipment provided for putting the scheme into effect. The same was installed under my supervision January, 1910, and was in successful operation in March the same year and has been used to date with entire satisfaction in every respect.

With reference to non-belief in publicity, would say that it has never been our purpose to keep from the tie and timber-treating world anything that pertains to the general good of the industry. The plant's operation is always open to inspection.

The air-pressure scheme greatly facilitated the operations of the plant and almost entirely eliminated the high cost of maintaining the ordinary force pumps, all of which have been discarded.

(Signed) W. L. Bacon, Supt. Treating Plant, C. & N. W. Ry.

The Arkansas & Memphis Railway, Bridge & Terminal Co. has awarded contract to the Union Bridge & Construction Co., Kansas City, Mo., for the construction of the sub-structure of the bridge to cross the Mississippi river at Memphis, Tenn. Contract amounts to about $1,250,000 and the total cost of the bridge will be near $4,000,000.

The Atchison, Topeka & Santa Fe has begun work on an addition to its shops at Topeka, Kan., to cost about $20,000.

Contracts have been awarded by the Canadian Pacific for 180 station buildings to be erected along its new line from Montreal to Toronto.

The Cumberland Valley, it is reported, will construct a single track bridge across the Potomac river at Berkeley Station, W. Va.

Bush and Gunpowder River Bridges

Longest Concrete Slab Bridges in America

The Pennsylvania R. R. will soon put into service two bridges of unusual interest on account of their length and type. These bridges are located about 5 miles apart, on the main line of the Maryland division of the Philadelphia, Baltimore & Washington Ry., on the line between Philadelphia and Washington.

The length of the Bush River bridge is 2752 ft., consisting of 105 spans, all of 26 ft. span center to center of piers, with the exception of one draw span which is 35 ft. There are 102 piers of similar design and dimension, two abutments, and a draw span and rest pier, of larger size.

The Gunpowder River bridge is 4962 ft. long, consisting of 188 spans 26 ft. center to center of piers, and one 35 ft. draw span; 187 of the piers are of the same dimensions, while the draw span and rest pier are larger, as in the Bush River bridge. The two abutments are also similar to those at Bush River.

The conditions at both these rivers were nearly the same, and as far as piers, spans, slabs, etc., are concerned, the two bridges were designed practically as one.

The old bridges crossing these rivers are pile bridges, which have been built, rebuilt, and strengthened, until there is a network of timbers under them. The bottom is extremely soft, which has necessitated frequent attention and additions to the bridge structures. A network of intermediate pile bents, caps, and stringers, is visible below the present structures, all of which attest the difficulty of obtaining a foundation.

From 150 to 200 trains per day pass over these double track bridges, and it was necessary to keep them open while constructing the new structures.

The rivers, at this point, are near to Chesapeake Bay; so near, in fact, that the effect of the tides is easily discernible. In calm weather there is a variation of about 1 ft. in water level, attributable to the tides. Under these conditions it is hardly necessary to mention that there is practically no current.

The effect of the tides, however, is not nearly so serious as the effect of wind. A good stiff wind blowing down stream will lower the water level 4½ to 5 ft. in a few hours; an up-stream wind raises the level very appreciably. The lowering of water in the Gunpowder River was a handicap in the construction work, but the depth of water in Bush River was enough so that the change did not affect the progress of the work.

As would be expected near the mouth of these rivers, with little current, there is a great depth of mud or ooze in the river bottom, and piles 75 ft. long were required.

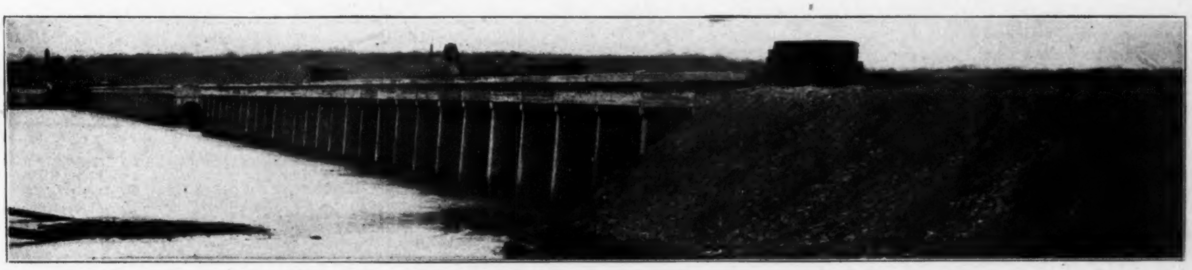
Design.

A study was made of the conditions to be met in these bridges in which the allowable maximum load on piles was 14 tons, giving a factor of safety of 4. The length of span determined the number of piles required, the size of footing slabs, and to some extent, the thickness of the piers, as well as the thickness and reinforcing of the floor slabs.

The effect of live load on a structure such as this is proportionately much greater than in an arch bridge, where, usually, the dead is so great as to greatly overbalance the effect of dead load. However, an excessive length of span, in this bridge, would have made the dead load to be carried much greater, and would thus have increased the number of piles, width of footings, and probably the width of the piers. When the cost of piles and pile driving was considered in relation to all these other conditions, the economical span length was determined upon as 26 ft.

The live load assumed in design was a standard 213-ton locomotive on each track, followed by a corresponding uniform live load. To this was added the impact allowance from Pennsylvania specifications, which give tabular values for different span lengths. The impact effect on structures such as these being described, is less than that on a steel structure, but much greater than on a massive arch bridge.

As shown in the illustrations, the dead load of the piers was materially decreased by two arched openings, made by using collapsible steel forms. Roughly, this gives a saving of 6,500 lbs. on each pier, which, taken with the concrete yardage on 293 piers, shows a very appreciable item.



General View of Gunpowder Bridge.

Footings and Piers.

A number of test holes were put down to determine the nature of the material in the river bottom. These showed soft river mud, blue clay, and fine gravel, considerable variation in depth being noted.

Test piles were driven at much closer intervals than the test holes were sunk, one test pile being driven at every fourth pier. These were all correctly located, so that the test pile formed one of the permanent piles used later under the footings. The extra cost of driving these piles was practically nothing, except that they were driven much harder and longer after striking the impervious strata. A careful record of the penetration of these piles was kept, and the results were plotted, showing the relation of penetration to number of blows of the hammer, as shown in one of the typical curves.

The penetrations of these test piles were also plotted on the profile, and a line of "desired penetration" was plotted. From this profile notes were taken showing the desired penetration at each pier, and then notes were furnished the inspector and pile driver crews.

The depth attained in pile driving shows that practically no piles penetrated below this line, although it was required that they be driven still farther if any appreciable penetration was being attained at that depth.

The ordinary piers have 31 plumb piles, and 12 batter piles driven at an angle of 1 horizontal to 6 vertical, as shown in the typical pier plan. The footing is 10 ft. wide, 33 ft. long, and 6 ft. thick. The pedestal on top of the pier is 5 ft. wide at the top, sloping down in a depth of 3 ft. to 5 ft. 4 ins. at the

bottom. The batter on the ends of the pedestal is the same, namely 1 ft. 2 in. in 3 ft.

The tops of the footings were designed to be at the elevation of the river bottom, and three sizes were used, varying slightly in dimensions, as shown on the drawings.

The piers and footings are provided with some reinforcing, added to take care of unequal strains or settlements, although not necessary under the assumptions for design. The footings have longitudinal and transverse 1 in. square twisted bars as follows: 2 longitudinal 33 ft. long, just outside the vertical pier bars; 10 transverse bars on about 3 ft. centers, with an extra one between the two bars at center of piers.

The piers have a batter of ¾ in. to 1 ft. on all sides. The width under coping is 2 ft. and the width at the bottom is 3 ft. 7 in., 3 ft. 8 in., and 3 ft. 9 in., in the different groups. The corresponding height of piers is 17 ft. 4 in., 18 ft. 0 in., and 18 ft. 8 in.

The upright rods in the pier face are not exactly vertical, but follow the face batter, 4 in. from concrete surface. These bars and are shown in the diagram herewith.

The top of the coping is 2 ft. 8 in. wide and 1 ft. thick, the coping offset being accomplished by curves of 8$\frac{13}{16}$ in. diameter. The ½ in. bevel, 4 in. wide, shown in the detail, is to prevent spalling off of the pier edges or entire coping offset, under even an excessive slab deflection. Note that the offset of the coping is 4 in., the same as the width of beveled edge on top.

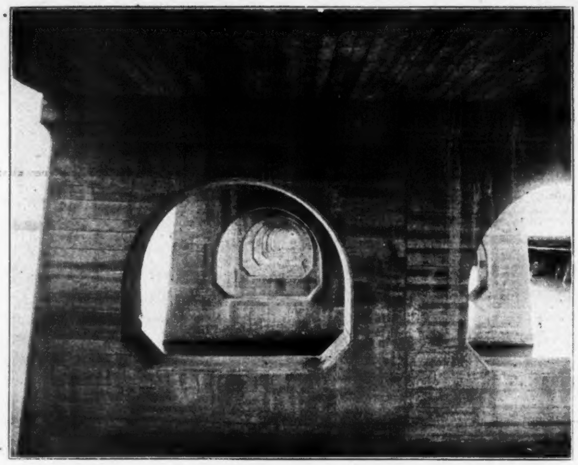
Abutments.

The design of the abutments is somewhat similar to the piers in that practically the same number of piles is used, spaced in a similar manner under the same sized footing slab. The batter piles, however, are all in the front, or in the side opposite the earth thrust. The face of abutment has a batter of over 1 in 3, and the back is plumb. No wing walls are necessary because there is practically no current and no danger of the fill being washed out from around the abutment.

Floor Slabs.

The floor slabs are 26 ft. long, with a clear span of 24 ft. They are 2 ft. 10 in. thick, and 28 ft. 4 in. wide, out to out of slab proper, for two tracks. The parapet extends 1 ft. 2 in. beyond this point and slopes down 1 ft. 2 in. inside this point, giving a width of 30 ft. 8 in. over all, and a flat interior width of 26 ft. The parapet is designed with reinforcement, the offset being obtained similar to that for pier copings, with a curve of 1 ft. 2 in. radius.

The reinforcing plan of the floor slab is exceptionally plain. The rods in the bottom, designated "a" are all bent up 10 ft. 5 in. from center, as shown in the detail. The bars in the second plane, staggered, above the first, are labeled "b" and



View Under Gunpowder Bridge Showing Openings in Piers.

"c" and the detail shows the bends for these rods. Rods "d" and "e" are short rods forming the horizontal lower plane reinforcing beyond the bends in the long rods "b" and "c".

Double stirrups were used, and the reinforcement was wired to the stirrups at intersections. The bottom bars were supported on the stirrups, the latter resting on small concrete blocks. The use of these stirrups made rod spacing very easy; in fact, it was practically impossible to get wrong spacing unless the two sizes of stirrups got mixed.

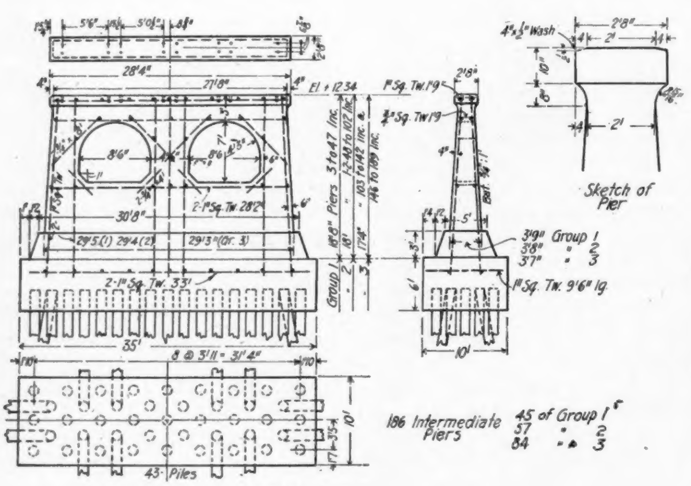
The tops of the floor slabs have a drainage slope from all directions to the 4 in. drain pipe placed at the center of the slab. The water will drop down directly into the river from these pipes. There is very little river traffic, and the drip from one slab will never be sufficient to cause serious objection to small boats.

The ballast to be used will be crushed stone passing a 1 in. ring. The depth of ballast below ties will be eight inches.

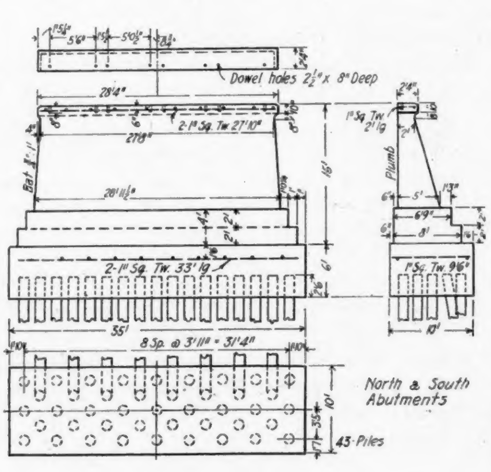
Mixtures, Finish, and Appearance.

The mixtures used were as follows: Foundations, 1:2:4; piers, 1:2½:5. Both of these mixtures were made with coarse aggregate consisting of washed gravel. The slabs were of a 1:2:4 mixture, using crushed stone passing a 1 in. ring.

The concrete was mixed wet, so that no tamping was required. The concrete was well spaded next to forms and no further finish was used. The tops of the slabs were simply smoothed off with the backs of the workman's shovels. The sur-



Typical Pier.



Typical Abutment.

face, however, presents a very dense and smooth appearance, and the drainage slope of 1 in. was well maintained.

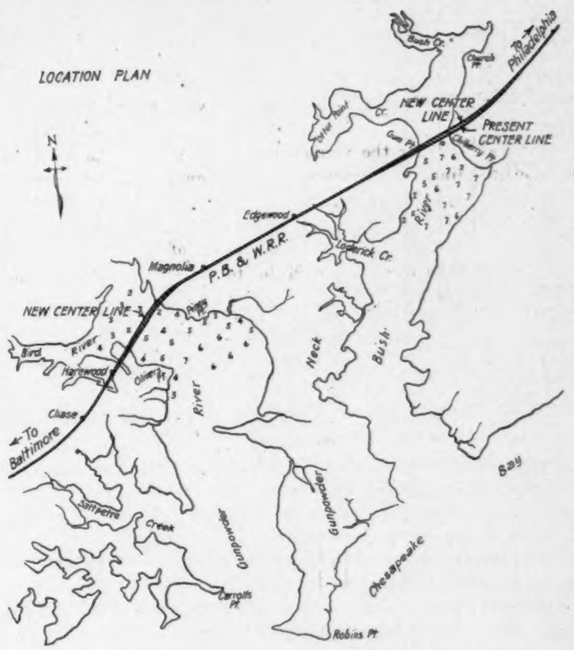
This bridge is located in a rather thinly populated district, so much so in fact, that the railway company found it necessary to build camp structures for the forces. The bridge, therefore, will be seen by few people except those riding in the trains, and then only the top will be visible. For these reasons, no special attempt was made to make the structure beautiful. However, the type is admirable for such a long low structure. The appearance is greatly enhanced by the curves under copings and parapets, and by the twin arch openings in the piers.

Construction.

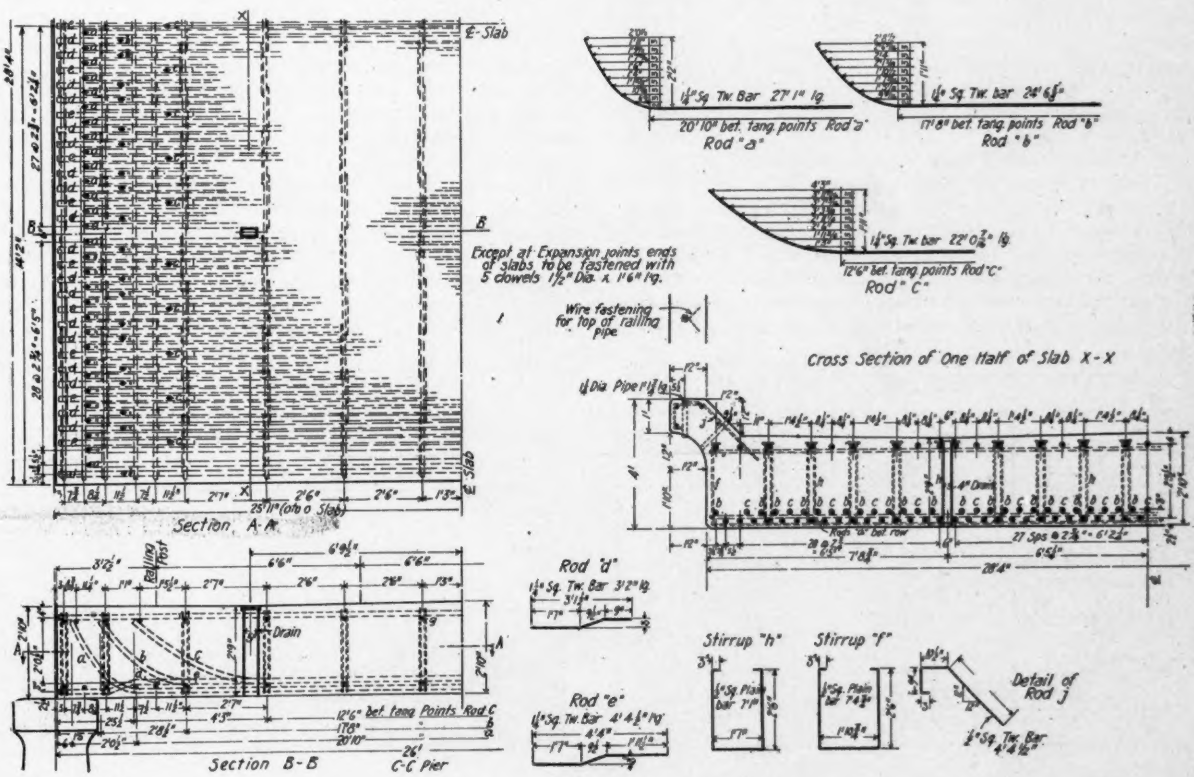
It was necessary to keep traffic open on the old bridges and so the new structure was built on a new alinement. Even had it been possible to hold up traffic for limited periods, it would have been practically impossible to have driven cofferdams around the old bridges, due to the tanglement of old structure timbers, of much of which there was no definite plans or knowledge.

The alinement of the new bridge was figured to fill the following requirements: Minimum working distance from old structure, 40 ft.; connection with old tangent alinement to be made with one simple curve, in other words without a reverse. The right of way was ample, but it was desired to put in the new bridges with as few new curves as possible, namely, two, where the new line joins the old lines. These conditions were met by compounding and easing off the curves at both Bush and Gunpowder rivers, and throwing the new bridge alinement on a slight angle with the old. For convenience in field work, this angle was made 30 minutes, and when the curve at intersection with old tangents is put in there will be little more than a kink at the point of intersection. Although this scheme is not new it was an ingenious solution of the problem.

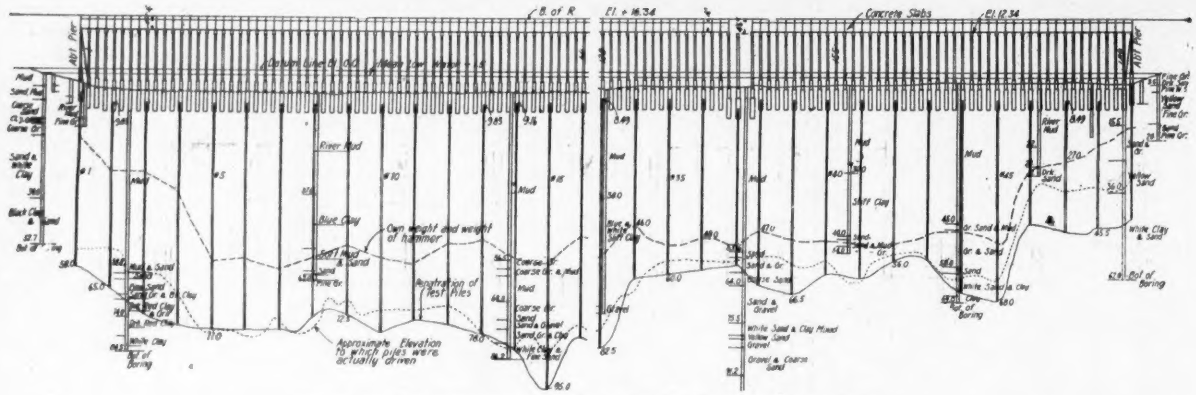
The center line for the bridges was carefully laid out and measured on the ice in the winter, making careful corrections for temperature, and using a standardized tape. The old bridges were used as base lines and the new line was tied in at numerous points. At each bridge, on the shore of the rivers, a small concrete pier was erected on center line, with three wooden blocks inserted for the tripod legs. The point was carefully located on this pier. A foresight was carefully located in the winter, and a substantial monument erected. Thus practically all the points were located using a foresight. Perma-



Alinement and Location Map.



Details of Slab Reinforcing.



Profile of Pile Penetrations, and Elevation of Gunpowder Bridge.

nent back sights were established, but were only used when the foresight was obscured by smoke, hazy weather, etc. Orders were given to check all points set by back sight, at the earliest opportunity by using the foresight.

The excavation consisted entirely of river mud, of the consistency of silt. This material was all removed by pumping.

The piling was driven by steam hammers, attempting to reach the "desired penetration" with each pile. In some cases, however, it was impossible to obtain the penetration, due probably to the piles striking a conglomerate, portions of which were uncovered in the excavation for roadway on the river banks. Whenever it was impossible to obtain the desired penetration two extra rows of piles were driven for the pier, and the footings were spread. Hammers weighing 10,500 lbs. were used to drive the piles.

Wooden cofferdams were used, constructed of 6x10 in. sheet piling with beveled spline. This piling was driven with a small 1,500 lb. Acme Arnott steam hammer, which had a rapid action and gave excellent satisfaction. The piling was used a good many times before wearing out. This was due to the good heavy timber used, the softness of the river bottom, and the light hammer used for driving.

The pumps which pumped out the mud excavation were located on a small barge. Very little working of the mud with poles was necessary, and no difficulty was experienced in pumping the material 2,800 ft. through 12 in. pipes.

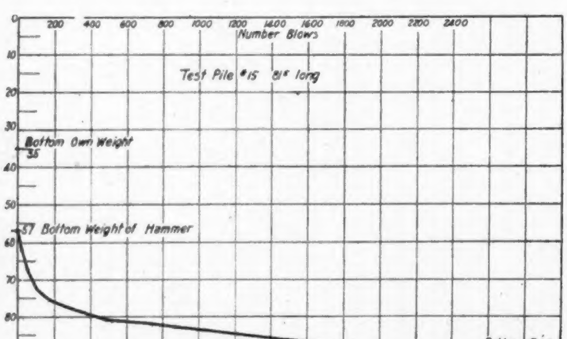
The piles were cut off so as not to penetrate more than 2 ft. into the footing, provided the desired penetration was obtained. Where the first pile in the pier brought up above this point, the remainder of the piles were sawed off accordingly, so little cutting off of piles was necessary after driving.

Some difficulty was experienced in putting in the concrete footings, due to the softness of the ooze or mud, and some experiments were made to determine the best methods of sealing the bottom.

The first method used was to put in the footings (under water) and clean off the laitance before placing the pedestal. This method early proved to be expensive and unsatisfactory. The next method used was to put in a 6 in. layer of concrete very carefully, and leave that to harden, but the mud still came up. The final process adopted was to seal the bottom with gravel. This method was worked out as follows: A large wooden funnel was built, with an opening so small that the gravel would not run out fast enough to stir up the mud. This funnel was loaded with gravel and slowly moved around over the cofferdam. This process was continued until a layer 1 ft. thick was placed, and then it was ready for the concrete. This process was found to work out very well indeed, and no more trouble was experienced with the mud coming up. The gravel was spread in such small quantities as to cause practically no disturbance of the mud.

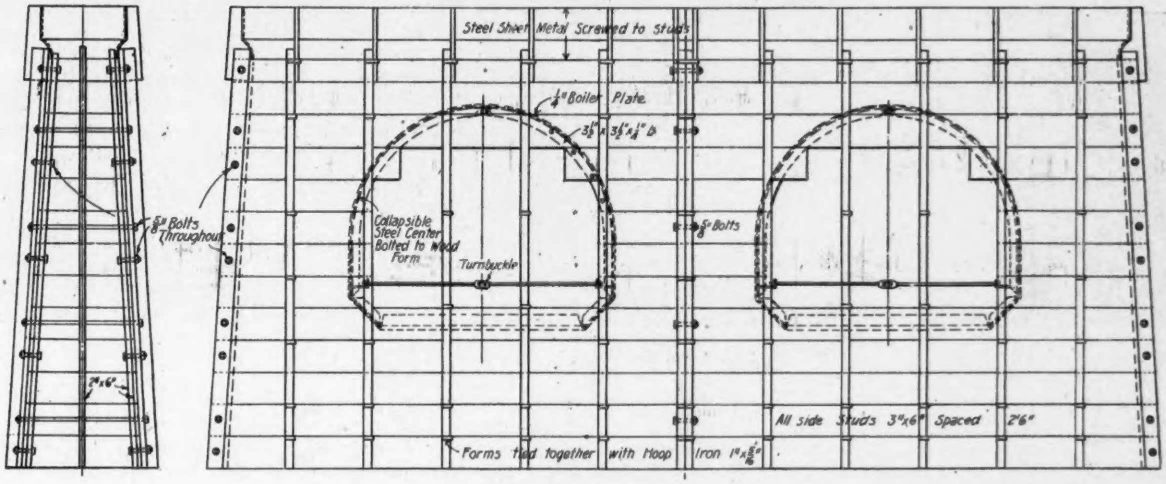
A concrete plant was built at each river, on barges. A large hopper divided into two parts was kept supplied with sand and stone by a clam shell bucket, loading from barges alongside, one barge for sand and one for stone. The cement was stored on the main barge, and in the first plant built, at Bush River, the cement was carried to the mixer by laborers. In the other plant the cement was carried forward by an endless chain conveyor.

The stone and sand were fed into the mixer from the hopper. The method of measuring the water was unusual. It was furnished through a 3 in. pipe under uniform pressure, and the amount was regulated by the time the valve was open. The inspector communicated with the man handling the valve, specifying "5 or 10 sec. more," or less, as desired. This method worked out very satisfactorily. Of course it is necessary to



Typical Curve of Test Pile Penetration.

Showing Large Amount of Equipment Working Without Interference.



Details of Pier Forms.

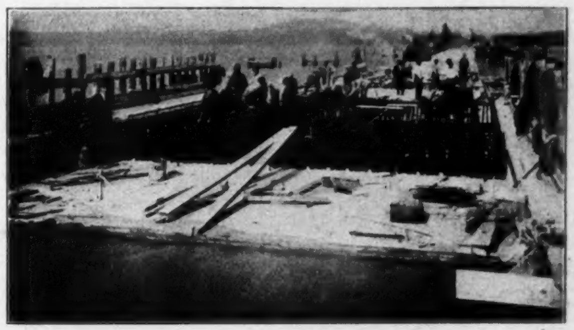
have a large enough pipe to give the proper volume of water quickly.

The concrete was raised in an elevator to the top of the tower, shown in one of the illustrations, and chuted into place. Concrete for all footings was deposited under water, and care was taken to have the bucket full, to decrease the danger of eddies washing out the cement on the top.

The forms for the piers were made in one section in the Bush River work, and in six sections for the Gunpowder work. The unit forms had to be handled entirely with derricks, and little advantage was gained over the six piece forms. The forms were braced from the cofferdams ahead and behind, and also tied back with rods anchored in piers previously poured. These rods were wound with soft felt paper, and were easily removed after the pier had set, and were used over and over. The holes were pointed up with cement mortar.

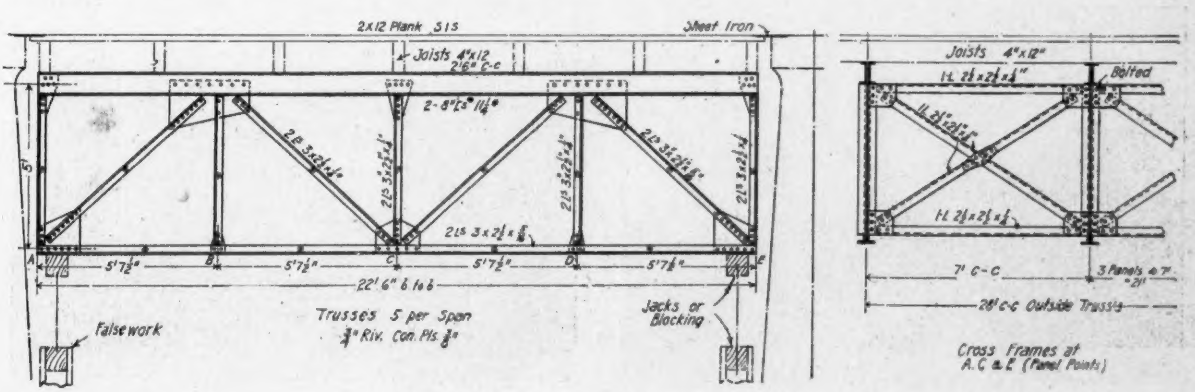
The diagram herewith shows the construction of the pier forms, and collapsible metal ribbed forms for pier openings. These collapsible forms were made of ribs of 3½x3½x¼ in. angles in 5 parts. The upper ones were bent to the radius of 4 ft. 3 in. Quarter inch boiler plate was bolted to these angles. Small wooden wedges were inserted between 3 joints in the steel ribs, to be driven out when striking the forms. The angles were bolted to the wooden pier lagging and aided considerably in holding the pier forms in proper alinement.

The supports for the slab forms consisted of five longitudinal trusses on 7 ft. centers. The construction of these trusses is well shown in the plan. The economy of steel truss supports is apparent, there being about 290 spans of the same length in the two structures. These trusses were set up on jacks, and upright timbers with wedges between, resting on horizontal transverse timbers which in turn were supported on the pedestals of the piers. A timber stringer was placed on top of the jacks on which the trusses rested. The jacks were used to bring the trusses to the proper height, and also to let down the trusses when striking. These trusses were let down directly onto a barge and towed to next pier by a gasoline tug boat. The forms for one span were frequently collapsed, hauled to new position, and jacked up into place in 3 hours.

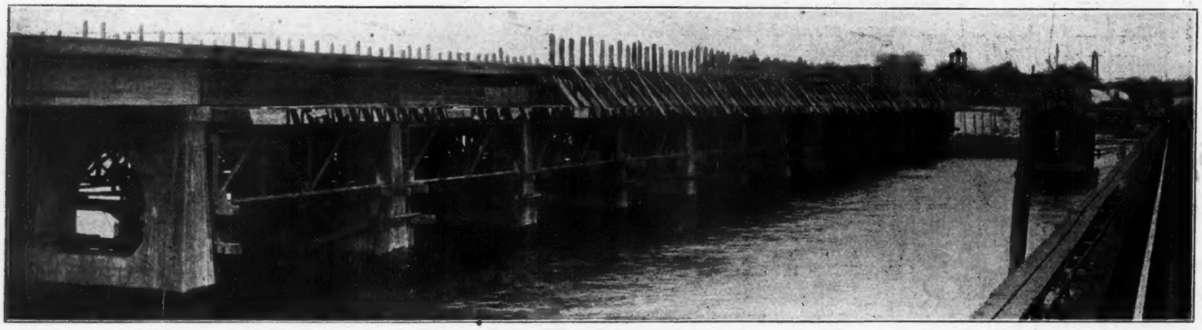


Reinforcing for One Floor Slab, Weight 13 Tons.

The lagging for the floor slabs rested on transverse beams, which extended 4 ft. beyond the parapet forms. The side forms



Truss Supports for Slab Forms.



Slab Form Supports and Side Bracing.

were braced on stay planks nailed on the ends of these beams, wedges being provided for adjustment to keep the side forms in line. It was found necessary to watch these wedges closely, as when the forms were loaded the side wall lagging was bent out of line. It was thought that the trusses were designed heavy enough so that the difference in deflection would be negligible. The outer trusses, theoretically, carry only half as much load as the interior ones. A theoretical method of keeping these trusses uniformly loaded would have been to cantilever the outer portion of the beams 2 ft. 11 in. and make the spacing of the 4 interior trusses 5 ft. 10 in. Each truss would then support a slab 5 ft. 10 in. wide. The ends of the cantilever beams would have to be braced up by some means if such a system was worked out.

The trusses were made without camber, the allowance for settlement being obtained by using beams of graduated thickness in the floor forms. The allowance made was ¾ in. for the 26 ft. spans. The reinforcing for one slab weighs about 13 tons, and was usually placed by 10 men, and wired, in about 6 hours. The stirrups were blocked up concrete block with grooves for the stirrups; the groove in these blocks absolutely prevented any of them working out from under and letting the stirrups down. One block was placed under the center of each stirrup, the stirrups supporting all other reinforcing. After the reinforcing was placed, and just before pouring concrete, the forms were flushed out with a hose and a stream of clean water under heavy pressure, all dirt being washed into drain holes.

The slab forms were poured alternately, making it necessary to build two bulkheads for ½ the slabs, and none for the remainder. This method was found to be very advantageous, as it eliminated any chance of the work of the form men interfering with the work of the concrete gang.

Expansion joints were provided at every third pier. These were made by using 8 layers of cheap felt paper, making a thickness of 1 in. This paper was delivered in rolls 36 in. wide, which were cut in two with a cross cut saw. A layer of this paper was placed on top of piers at expansion joints to prevent any bond being formed when pouring the slabs. The expansion joints were covered by an iron cover plate 1 ft. wide, anchored to one slab and free to slide on the other. Special pains was taken to make the surfaces under this cover plate smooth, so that no ballast would work under and into the joint.

Inspection.

The inspection on the work was very complete. It was especially strict with regard to the quality and cleanness of the sand used in concrete. There is danger in these days when concrete is being used so extensively, that the matter of clean sharp sand will be underestimated, but no chances were taken in this work.

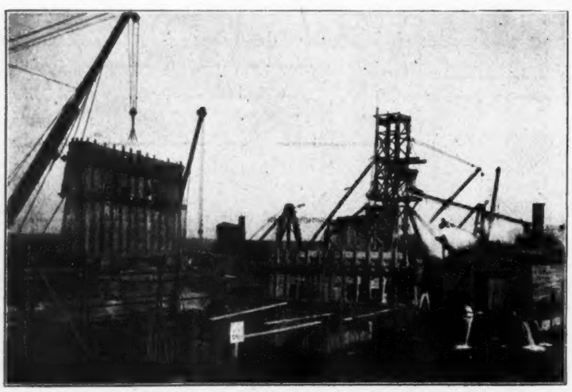
Two inspectors were assigned to each concrete mixing plant. One inspector watched the proportions going into the drum, and the other looked after the spading and consistency of the mixture. All rods were inspected and required to be cleaned of rust before concreting.

Comparison of Concrete Plants.

Sand and stone was delivered from barges loaded at Baltimore and towed to the work. The work on the Bush River bridge was accomplished more advantageously because the water in the old draw span was deep enough to allow barges loaded with sand and stone to pass through at all stages of water. Thus there was no re-handling of these materials.

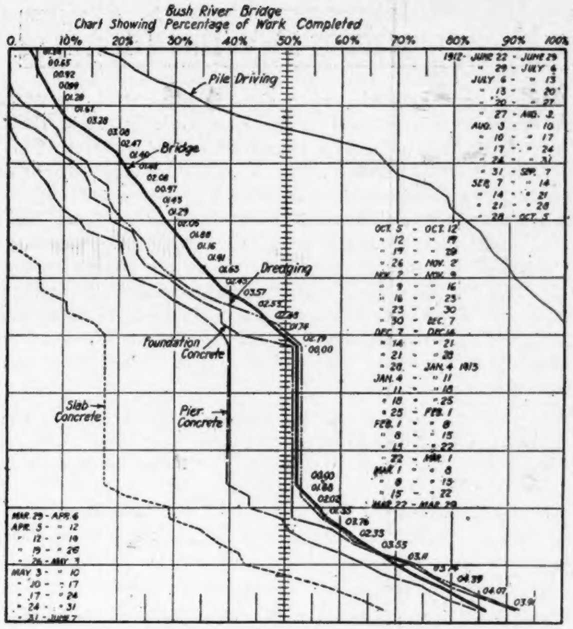
In the Gunpowder River work it was necessary to pass all this material under the track and reload it on other barges. This work was done very efficiently by an endless chain conveyor, which was rigged up on falsework. However, this extra handling of material added considerably to the cost of the work.

The Bush River plant was constructed first, it having been decided by the contractors previous to submitting a bid that the concrete plants would be most advantageously located on barges. When the depth it would have been necessary to drive piles for a temporary trestle is taken into consideration, the advan-

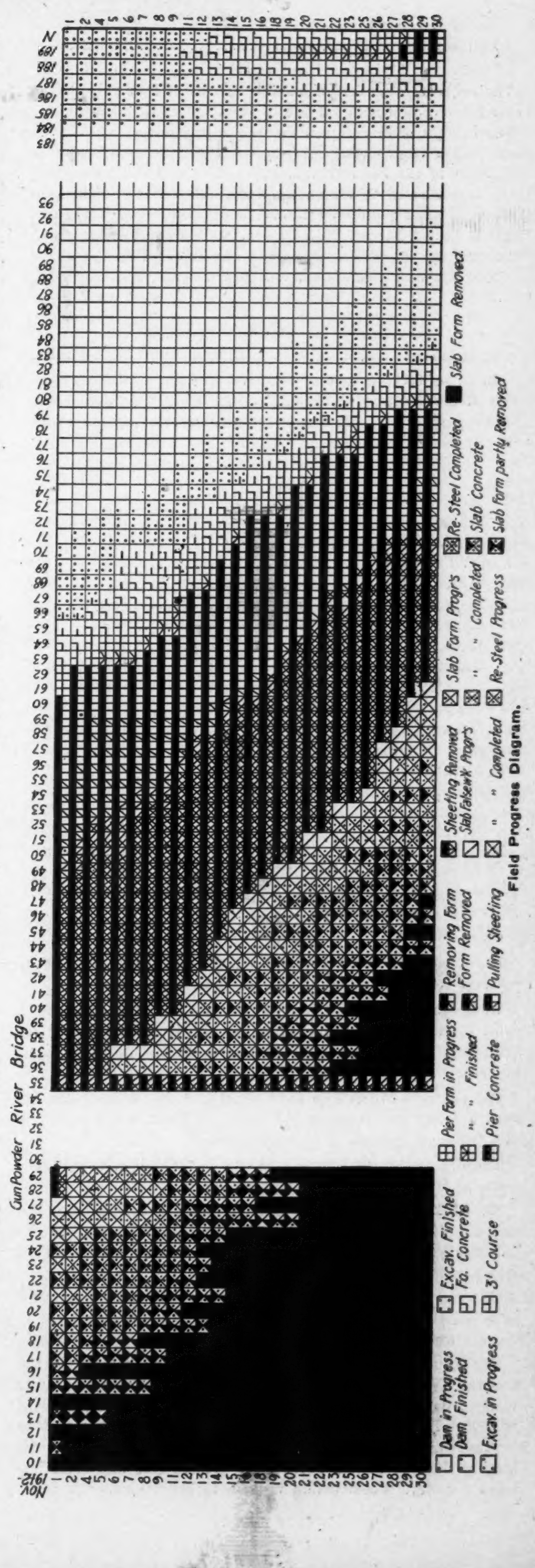


Handling Unit Pier Form With Derrick.

Completed Slab, Reinforcing Being Placed in Second Span Ahead.



Curves Showing Progress at Bush River.



Field Progress Diagram.

tage of this method is apparent. The barge used at Bush River, however, proved a little too small for greatest efficiency and a barge of considerably greater size was used in the other plant. A chain belt conveyor also was installed in the latter plant, and cut down the force of laborers required very appreciably. On the latter plant, in fact, practically no laborers were required in the plant proper, except one or two to load sacks of cement into the conveyor.

The Bush River plant used a sheet iron chute, held in approximate place by cables from a derrick boom. The chute in the Gunpowder River plant was a great improvement. It consisted of two I-beams of sufficient size to give great rigidity. In the plate forming the bottom of this chute there were made three discharge holes, capable of being easily closed. The chute was located over a pier and concrete could be chuted through any hole desired by adjusting the slides and dams in it. This chute was made long enough to easily reach entirely across the piers, this being possible on account of the rigid construction.

The pile drivers, steam hammers, pumps, and in fact, all machinery, was placed on barges. The advantages are manifest. A single track trestle would have been constantly more or less congested on these bridges. Except occasionally during low water, it was possible to tow these boats around each other to almost any desired location. During low water, however, the depth of water in Gunpowder River was not always sufficient to keep the larger barges afloat.

The progress report chart reproduced herewith is that kept by the engineer in the field. It appears rather complicated at first glance, but is readily intelligible after it has been used for a few days. The dead black represents completed structure. The space from 30 to 34 is to be left till the last, for barges to go through. The symbols are shown on the illustration.

An idea of the size of these combined jobs, which were let out in one contract, is given by the following quantities of materials, etc., handled in the construction:

Combined length of bridges, feet	7,714
Number of plumb piles	10,249
Number of batter piles	3,528
Total number of piles	13,777
Number of yards excavated (wet)	97,000

Yards of concrete masonry	76,400
Reinforcing rods, tons, about	3,850

The order for reinforcement was second in size only to the order for reinforcement for use in the Panama Canal work.

The bridges were designed under the supervision of Alex C. Shand, chief engineer, in the office of H. R. Leonard, engineer of bridges of the Pennsylvania R. R. The field work was done under direction of C. W. Thorne, assistant engineer. The contract was taken jointly by Henry Steers, Inc., New York, and Brann & Stuart, Inc., of Philadelphia. John Simmons was superintendent for the contractors. We are indebted to the above for the data and plans contained herein.

VALUATION OF COMMON CARRIERS.

Large Number of Positions Open in United States Civil Service.

On June 14th and 24th the Civil Service Commission announced examination to be held on the dates indicated herein for the purpose of recruiting a force for service in connection with the valuation of common carriers:

No.	Title of Examination	Set for
656	Senior structural engineer	July 21, 1913
657	Structural engineer	July 23, 1913
658	Senior civil engineer	July 21, 1913
659	Civil engineer	July 23, 1913
660	Senior inspector of car equipment	July 21, 1913
661	Inspector of car equipment	July 23, 1913
662	Senior electrical engineer	July 21, 1913
663	Electrical engineer	July 23, 1913
664	Senior inspector of motive power	July 21, 1913
665	Inspector of motive power	July 23, 1913
666	Senior railway signal engineer	July 21, 1913
667	Railway signal engineer	July 23, 1913
668	Senior mechanical engineer	July 21, 1913
669	Mechanical engineer	July 23, 1913
670	Senior architect	July 21, 1913
671	Architect	July 23, 1913
711	Examiner of accounts	July 28, 1913

With a number of these positions it is not necessary to assemble anywhere for examinations, the applicant being rated mainly on experience, etc.

The Alabama, Tennessee & Northern has been awarded a contract for the building of new shops at York, Ala.

Westinghouse, Church, Kerr & Co. has recently commenced work on terminal improvements for the Canadian Pacific at Winnipeg, Man., which will involve an expenditure of nearly $1,500,000 and will require two years to complete.

The Chicago, Milwaukee & St. Paul and the Minneapolis, St. Paul & Sault Ste. Marie are planning to build a union freight and passenger station at Menasha, Wis.

The Chicago, Rock Island & Pacific is building a new roundhouse and repair shop at Invergrove, Minn.

W. A. McGonagle, of the Duluth, Missabe & Northern, has announced that immediate steps will be taken in regard to the building of a viaduct for the railroad tracks over Highland street at Duluth, Minn.

The Kanawha & Michigan, it is reported, will erect new shop buildings at Pomeroy, O.; this shop is to be completed in August of 1913.

The Louisville & Nashville has awarded a contract to the Central Concrete Construction Co. for a reinforced concrete viaduct over Jefferson avenue, Lexington, Ky., to cost about $64,000. It is also reported that this road will make further improvements to its shops and yards at Birmingham, Ala., enlarging them to almost twice their present size and establishing a foundry. Construction work is to begin soon.

Twenty Years Ago This Month

Twenty years ago this month eight hundred steel ties of a new design were purchased by the New York Central & Hudson River R. R. by order of Walter Katte, chief engineer. This tie is described in the July, 1893, issue of the *Roadmaster and Foreman*, now incorporated in *Railway Engineering and Maintenance of Way*. The ties were laid with 80-lb. rails in stone ballasted double track on the main line. Mr. Katte was very sanguine of the success of the tie, which was known as the "Hartford.". The cost of southern pine untreated ties at that time was fifty-five cents each, while the steel tie cost three dollars. Mr. Katte reported an estimated total saving on track maintenance in favor of the metal tie amounting to between 8 and 12 per cent.

The Forestry Division of the Department of Agriculture was interested in the tie problem and during July, 1893, this exhibit of the Government at the World's Fair attracted many railway engineers. Metal ties in use throughout the world were shown by colored drawings. It is interesting to note that the steel tie was then considered the only solution of the tie problem, then more perplexing than now.

G. A. Demore, now a roadmaster on the New York, New Haven & Hartford, was, in July, 1893, becoming acquainted with new duties as assistant roadmaster of that system under C. C. Elwell, roadmaster.

The famous Halsted street lift bridge in Chicago, designed by J. A. L. Waddel of Kansas City, was nearing completion.

Projected 600 years before Christ, and actually begun by the Emperor Nero, the canal through the isthmus of Corinth was completed in July, 1893.

Track elevation was being agitated in Chicago, Minneapolis and other cities. Notices had been served upon railways to proceed to elevate their lines forthwith. Little or no attention was given the matter on the part of railway officers until several years later.

An English company submitted a proposition to build a railway bridge across the English channel. The estimated cost of the work was $160,000,000. The number of piers was to be 72 with spans of about 1,500 feet.

A "rainmaker" operating in an especially equipped car was sent into Kansas by the Chicago, Rock Island & Pacific Ry.

July, 1893, was a blue month for the engineering as well as the other departments of most railways. Nearly all construction work had been stopped. Double track work on the Pennsylvania lines, which had been started some time previously, was discontinued. Maintenance forces throughout the country were cut to the ordinary winter gangs. In addition a general 10 per cent decrease in all monthly salaries was simultaneously put into effect by a number of roads.

In July, 1893, the New York Central had just started a twenty-hour service between New York and Chicago. The train was made of Wagner Company cars "with vestibules covering almost the entire platform." The train weighed 200 tons.

The Paducah & Illinois, it is reported, will let contracts this month for the construction of the bridge to cross the Ohio river at Metropolis, Ill.

The Philadelphia & Reading has asked for bids on 1500 tons of steel for additional grade crossing work in Philadelphia, Pa.

The Committee on Streets and Bridges, Woonsocket, R. I., has awarded the contract for the construction of the new Harrison Avenue bridge to S. Brien & Son and J. C. Bouvier at about $14,000. The structure, which will be of reinforced concrete, will span the cut through which the New Haven tracks run at Harrison Avenue.

Design of Retaining Walls*

By Alfred W. Hoffmann.

2nd Group. Reinforced Concrete Retaining Walls

General. By reinforcing a concrete retaining wall with tension steel bars, it is possible to make better use of the compressive strength of concrete than can be made in a gravity wall. In a homogeneous concrete structure which is subjected to bending moments, the compressive fibre stress is equal to the tensile fibre stress, and the allowable compressive stress is, therefore, limited by the exceedingly low tensile strength of the concrete which is only a small fraction of its compressive strength. By placing the steel reinforcement so that it takes tensile stresses any compressive stress up to the allowable on the concrete can be obtained by the selection of the corresponding percentage of steel reinforcement. Reinforced concrete retaining walls are of lighter weight than plain concrete walls; they depend for their stability not only on their own weight, but also on the weight of the portion of the back fill which is carried on the back or on the heel.

The fill being, in most cases, lighter than concrete, it is evident that, as a rule, a wider base is required for a reinforced gravity retaining wall with a base of .4 of the height will answer the purpose, no matter what the soil and the surcharge may be, will look into these conditions very carefully if a reinforced concrete wall is contemplated. There are practically no general rules for the design of reinforced walls, and an analysis in each individual case is the best safeguard against undesirable deformations.

Long walls, reinforced or plain, should be built in short sections, and the exposed surface of the reinforced walls should always be protected from temperature cracks by a light reinforcement well distributed over the whole area.

Type III. This type resembles the gravity types I and II, in general proportions, stability and toe pressure. The area of the concrete section is reduced in the back, front or footing, and steel is placed where the tensile stresses are increased by the reduction of the concrete section. Figures 39, 40, 41, 42, 43 and 44 show some variations of this type, which is economical for heights of about 10 ft. to 18 ft.

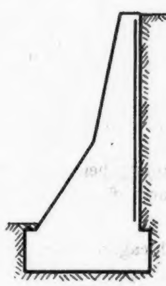


Fig. 39


Fig. 40


Fig. 41

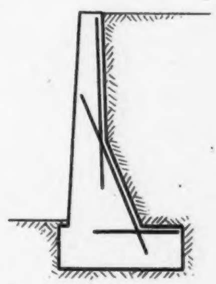


Fig. 42

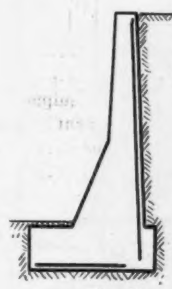


Fig. 43

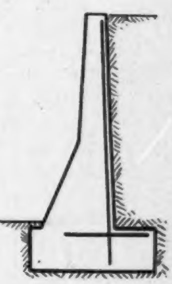


Fig. 44

concrete retaining wall than for a plain concrete wall, of the same height and degree of safety against overturning. This calls for an increased volume of excavation, which, in comparing the economy of various types, should be charged against the reinforced wall.

The economical percentage of reinforcement varies considerably with the height of the wall. The economy of plain gravity walls cannot be disputed for height up to about 12 or 16 ft. For greater heights, however, the reinforced concrete wall is, in most cases, cheaper, and with increasing height the percentage of reinforcement should be increased too.

Failure of reinforced concrete retaining walls with low percentage of steel is, in most cases, due to the same reasons as failure of plain gravity retaining walls. Stability and toe pressure are the main causes to be taken into consideration. Failure of walls with a high percentage of steel may also be due to the same causes. There are, however, other factors to be considered which are sometimes more influential in causing failure. These new factors are the internal stresses and the deformations caused by them. While a gravity wall with a reasonable degree of stability and a low toe pressure will not fail, a reinforced concrete wall with the same or a higher degree of stability and the same or lower toe pressure may fail because of some weakness in the wall itself. In designing a reinforced wall, stability and toe pressure must be considered to determine the general proportions of the structure, and in addition, a careful analysis of the stresses in all parts of the structure must be made, and steel and concrete so detailed as to avoid excessive stresses.

Cracks do not give as much trouble in reinforced walls as in gravity walls. This may be largely due to the fact that reinforced concrete walls are designed more carefully than gravity walls. Sometimes the same engineer who is satisfied that a

The analysis is the same as for types I and II, as far as stability and toe pressure are concerned. After the diagrams for earth pressure, surcharge, and soil reaction are determined, various sections are to be analyzed for tension in steel and compression in concrete. For the wall shown in Fig. 45, the earth pressure, 10 ft. surcharge, and the soil reaction have been computed, and are shown in Fig. 46 a, b, and c. From these diagrams we find the shear and moment on section 2-2 to be

$$28.6 \times \frac{9^2}{2} = 1{,}160 \text{ lbs.} \times 3 \text{ ft.} = 3{,}480 \text{ ft. lbs.}$$

$$28.6 \times 10 \times 9 = 2{,}574 \text{ lbs.} \times 4.5 \text{ ft.} = 11{,}580 \text{ ft. lbs.}$$

$$\text{Shear} = 3{,}734 \text{ lbs.} \qquad M = 15{,}060 \text{ ft. lbs.} = 180{,}720 \text{ in. lbs.}$$

In an unreinforced section the fibre stress would be

$$\frac{180{,}720}{1/6 \times 12 \times 41^2} = 54 \text{ lbs. per sq. in.}$$

This figure exceeds the allowable tensile stress on the concrete, and a reinforcement is required of

$$A_s = \frac{180{,}720}{.9 \times 38 \times 15{,}000} = .35 \text{ sq. in.}$$

per lineal foot of wall, if the center of gravity of steel reinforcement is assumed to be 3 ins. from the concrete surface, and the allowable stress on the steel is 15,000 lbs. per square inch. The distance between the centers of compression and tension is assumed to be .9 of the effective depth. The compressive fibre stress is, then,

$$f_c = \frac{180{,}720 \times 2}{.9 \times 38 \times 12 \times .3 \times 38}$$

$$= \frac{180{,}720}{1.62 \times 38^2} = 77 \text{ lbs. per sq. in.}$$

* This is the third of a series of articles on this subject.

If ⅝-in. square bars 12 ins. on centers are used, the area of the steel section is .39 square ins. per lineal foot of wall. The percentage of steel at section 2-2 is

$$p = \frac{.39}{12 \times 38} \times 100 = .0855\%.$$

The average unit shear is

$$v = \frac{3{,}734}{12 \times .9 \times 38} = 9.1 \text{ lbs. per sq. in.}$$

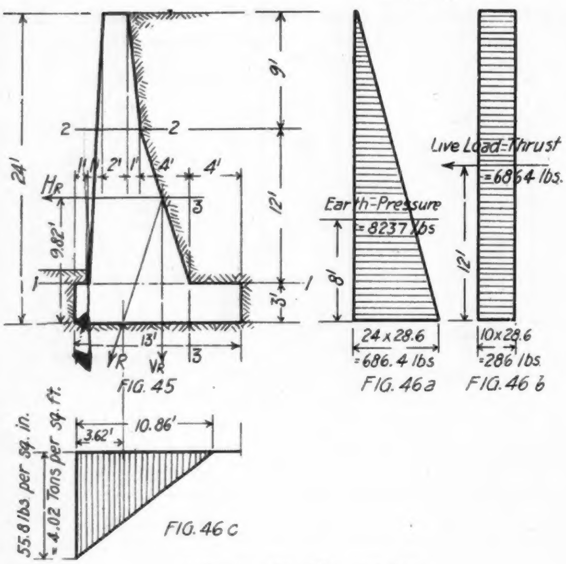
No web reinforcement is required, as the allowable shear on concrete in railroad work is assumed about 30 lbs. per square inch.

Similarly, we find for section 1-1 the following shear and moment:

$$28.6 \times \frac{21^2}{2} = 6{,}315 \text{ lbs.} \times 7 \text{ ft.} = 44{,}205 \text{ ft. lbs.}$$

$$28.6 \times 10 \times 21 = 6{,}005 \text{ lbs.} \times 10.5 \text{ ft.} = 63{,}055 \text{ ft. lbs.}$$

$$\text{Shear} = 12{,}320 \text{ lbs.} \qquad M = 107{,}260 \text{ ft. lbs.} = 1{,}287{,}120 \text{ in. lbs.}$$



Figs. 45, 46a, 46b, and 46c.

The reinforcement required is

$$A_s = \frac{1{,}287{,}120}{.9 \times 93 \times 15{,}000} = 1.025 \text{ sq. in.}$$

per lineal foot of wall. A reinforcement consisting of ¾ in. square bars 6 ins. on centers has an area of 1.12 sq. in., and a percentage

$$p = \frac{1.12}{12 \times 93} \times 100 = .1\%.$$

The compressive fibre stress is very low. The average unit shear is

$$v = \frac{12{,}320}{12 \times .9 \times 93} = 12.25 \text{ lbs. per sq. in.}$$

No web reinforcement is required.

The force acting on section 3-3 is the difference between the weight of the fill and surcharge carried on the heel minus the upward pressure of the soil against the base. It is sometimes recommended in text books to assume the wall to be on the point of overturning and to proportion the heel for the weight of the fill and surcharge disregarding the soil reaction which partially counteracts this weight. This does not seem to be good practice except where the soil reaction is very small as compared with the superimposed weights. Whether the wall fails by overturning or by excessive stresses in the heel seems immaterial. As long as the desired stability exists, there exists also the soil reaction which can be counted upon to reduce the load on the heel. This consideration applies more especially to heavily reinforced walls than to type III. The heel in type III is, in most cases, shorter than in types IV and V, and the soil reaction can therefore often be neglected.

Shear and moment on section 3-3 are as follows:

$$\text{Shear } V = 4 \times 3{,}100 = 12{,}400 \text{ lbs.}$$

$$\text{Moment } M = 12{,}400 \times 2 \times 12 = 297{,}600 \text{ in. lbs.}$$

The reinforcement required is

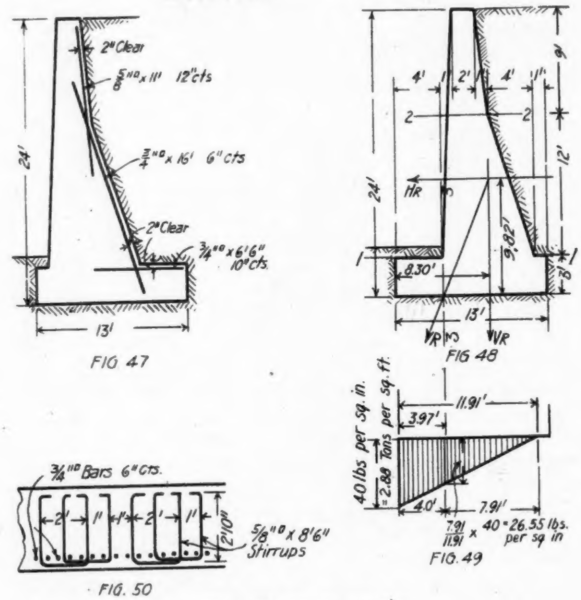
$$A_s = \frac{297{,}600}{.9 \times 33 \times 15{,}000} = .67 \text{ sq. in.}$$

per lineal foot of wall. This area is supplied by ¾ in. square bars 10 ins. on centers. The percentage is

$$p = \frac{.67}{12 \times 33} \times 100 = .169\%.$$

The average unit shear is

$$v = \frac{12{,}400}{12 \times .9 \times 33} = 34.8 \text{ lbs. per sq. in.}$$



Figs. 47, 48, 49, and 50.

This is slightly more than the allowable shearing stress; no web reinforcement is, however, required.

The reinforcement as recommended is shown in Fig. 47.

For the wall shown in Fig. 48, the soil reaction as computed is shown in Fig. 49. The shears, moments and stresses on sections 1-1, 2-2 and all other horizontal sections through the neatwork are exactly the same as in the wall, Fig. 45. To proportion the reinforcement in the toe, we find the shear at section 3-3

$$V = \frac{40 + 26.55}{2} \times 48 \times 12 = 18{,}200 \text{ lbs.},$$

and the moment

$$M = 26.55 \times 48 \times 12 \times 24 + \frac{13.45 \times 48}{2} \times 12 \times 32 = 460{,}000 \text{ in. lbs.}$$

The area of steel section required is

$$A_s = \frac{460{,}000}{.9 \times 33 \times 15{,}000} = 1.03 \text{ sq. ins.}$$

The ¾ in. square bars 6 in. centers supply an area of 1.12 sq. ins. and a percentage

$$p = \frac{1.12}{12 \times 33} \times 100 = .28\%.$$

The compressive fibre stress is, therefore, very low.

The unit average shear is

$$v = \frac{18{,}200}{12 \times .9 \times 33} = 51 \text{ lbs. per sq. in.}$$

A web reinforcement is required, to extend from section 3-3 to the vertical section, the shear on which is

$$12 \times .9 \times 33 \times 30 = 10{,}700 \text{ lbs.}$$

At section 4-4 (2 ft. 0 ins. from the toe) the shear is

$$V = \frac{33.2 + 40}{2} \times 24 \times 12 = 10{,}600 \text{ lbs.}$$

If 10,700 lbs. of shear is carried by the concrete, then 18,200 — 10,700 = 7,500 lbs. remain to be carried by the web reinforcement. Assuming that ⅝ in. square vertical stirrups are used, as shown in Fig. 50, then the spacing of stirrups is

$$\frac{.39 \times .707 \times 15{,}000 \times 33 \times .9}{7{,}500} = 16 \text{ ins.}$$

The detail of this wall is shown in Fig. 51.

Provision for drainage and against sliding is similar to that for types I and II. Temperature reinforcement will be discussed in connection with type IV.

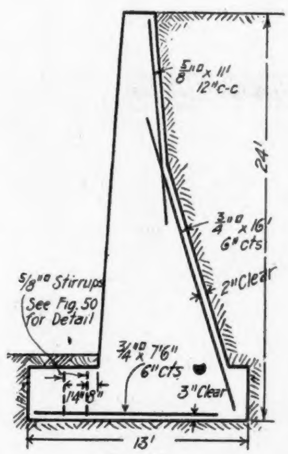


Fig. 51.

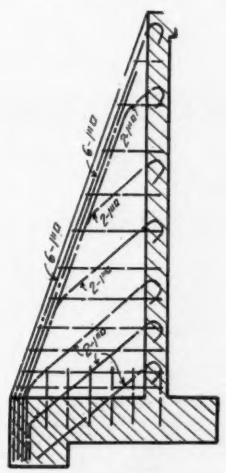


Fig. 62.

Deformation of the walls, Figs. 39 and 40, is but slightly more than for types I and II. The deformation of the wall shown in Fig. 45 is about

$$d = \frac{(21 \times 12)^3}{2{,}000{,}000 \times \frac{12 \times 96^3}{12}} \left(\frac{6{,}864}{8} + \frac{8{,}237}{15} \right) = .0127 \text{ ins.}$$

Type IV. L-Shaped Retaining Walls.

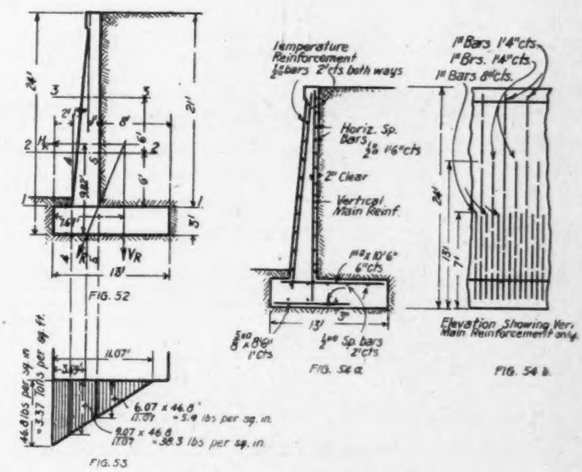
This type is similar to the one described before, and differs from it chiefly by the higher percentage of reinforcement. Fig. 52 shows a wall 24 ft. high of this type. The stability and soil reaction have been computed by the methods discussed before, and the result is shown in Fig. 53, which is the diagram of the soil pressure. Employing the same method for the computation of the stresses we find, in the horizontal section through the bottom of the neatwork, an average unit shear of 35 lbs. per square inch. A vertical tension reinforcement of 1 inch square bars 4 in. centers is required. At a horizontal section 6 ft. above the top of the footing, the vertical reinforcement required consists of 1 in. square bars 8 in. centers. At a section 12 ft. above the top of the footing the spacing of 1 in. square bars is 16 ins. It would be wasteful to let all the bars required at the bottom of the neatwork extend to the top of the wall, where only a small percentage is required. Fig. 54 shows how the reinforcement can be arranged, with a view to economy. Horizontal bars of small size should be provided, about 1 ft. 6 ins. to 2 ft. centers, to space the vertical main reinforcement.

In addition to the main reinforcement near the back face, the front face should be reinforced with small-size bars both ways, for temperature stresses. The temperature reinforcement should be about .2 to .3% of the area of the average concrete section.

The thickness of the L-wall at the bottom should be so proportioned that no web reinforcement is required, as it is difficult to place such web reinforcement.

The reinforcement in the footing has been determined by the methods discussed before.

The proportion of toe to heel must necessarily depend on local conditions. It is impossible to fix general rules for such proportions. If extensive rock excavation is necessary for a retaining wall, then a short heel is desirable. Fig. 55 shows a retaining wall differing from the wall shown in Fig. 52 only in the proportion of toe to heel. The diagram of the soil reaction for this wall is shown in Fig. 56. It will be seen that, by reducing the heel, the factor of safety and also the toe pressure is reduced.



Figs. 52, 53, 54a and 54b.

The deformation of the walls, Figs. 52 and 55, at the top, is about

$$d = \frac{(21 \times 12)^3}{2{,}000{,}000 \times \frac{12 \times 36^3}{12}} \left(\frac{6{,}864}{8} + \frac{8{,}237}{15} \right) = .24 \text{ ins.}$$

Type V. Counterfort Retaining Walls.

A retaining wall of this type is a more complicated structure than a wall of any of the other types. The wall is a continuous horizontal beam resisting the lateral earth pressure, supported by the counterforts, the toe is a cantilever resisting the soil pressure, the heel is a continuous beam supported by the counterforts carrying the weight of the earth fill minus a portion of the soil reaction, and the counterforts are cantilevers of the T-beam section. Much emphasis should be laid on the fact that both the front wall and the heel are *continuous* slabs, and should be reinforced as such. The horizontal main reinforcement in the front wall should be placed outside between the counterforts and inside at the counterforts. The best method is to provide a through reinforcement outside, and to use short bars at the counterforts. If, however, the spacing of the counterforts is very close, then it may be better to provide a through reinforcement both inside and outside. Sometimes bent bars are used to supply the section required at the center and at the counterfort with a minimum of steel. It is, however, rather difficult to place such bent bars and to hold them in position.

The theoretical moment of a continuous beam, both at the center and at the support, is $\frac{1}{12}\,w\angle^2$ for interior spans. It is, however, good practice to design the front wall for at least $\frac{1}{10}\,w\angle^2$, both at the center and at the counterfort. The span should be taken from center to center of counterfort. It is necessary to be very conservative, especially in the design of railroad retaining walls of this type, to minimize the danger of cracks. End spans should be figured for a moment $\frac{1}{8}\,w\angle^2$.

The thickness of the front wall at the bottom should be sufficient to carry the shearing stresses without a web reinforcement. If this requirement calls for too heavy walls, then the distance between counterforts should be reduced. Provision should be made in all cases for spacing bars and an adequate temperature reinforcement.

The same rules apply to the design of the heel, except that it is a very simple matter to place any kind of web reinforcement, either bent bars or stirrups in the heel slab. For this reason there is no restriction to the diagonal tension or average shear other than the limit of the allowable stress. About 100 lbs. per sq. in. average shear can be allowed in a concrete slab, for railroad work, which is properly reinforced with stirrups or bent bars. The main reinforcement is to be placed in the bottom between the counterforts, and in the top at the counterforts. The main bars are frequently placed closer together near the juncture of the footing with the neatwork. This detail is not in harmony with theoretical or practical considerations. At the juncture there is always a certain amount of the soil reaction to be subtracted from the weight of the backfill and the superimposed load. On the other hand, at the extreme end of the heel, there is either less soil reaction or none at all counteracting the weight. It is, therefore, logical and correct to space the main bars closer together at the outer edge of the heel than near the front wall.

The toe of a counterfort retaining wall is to be treated in exactly the same way as the toe of an L-shaped retaining wall.

If we pass a horizontal section through the counterfort, there is both a shear and a moment acting on the section under consideration. The shear is equal to the earth pressure plus the live load thrust above the section, and the moment is the product of the shear times the distance of the center of gravity of the shear diagram from the section. There can be no question that the counterfort is a cantilever, carrying shear or diagonal tension, compression near the front and tension near the back. Yet, a few years ago, Mr. E. Godfrey published a paper on counterfort retaining walls in which he makes the statement that the counterfort is a member in pure tension, and that the concrete in the counterfort takes no stress. If we establish equilibrium in any horizontal section, between the external forces and the internal stresses, we see directly that there exists a neutral line in the section, where the shear is a maximum, we see further that the stress to one side of the neutral line is compression, to the other side tension. If Mr. Godfrey's contention was correct, then the tension in the steel in the counterfort would necessarily be a constant value from top to bottom. It can be readily seen that both the shear and the moments are decreasing towards the top. It is therefore feasible and correct to gradually reduce the steel section between the footing and the top of the wall.

At any section the moment of the interior stresses is equal to the moment of the external forces. This latter moment being, for a certain section, a fixed amount, it follows that the internal stresses, both compression and tension, are smaller if the distance between center of compression and center of tension is increased. Neglecting, as we do, the tension carried by the concrete, it is economical and best practice to concentrate the main steel reinforcement as near to the back face of the coun-

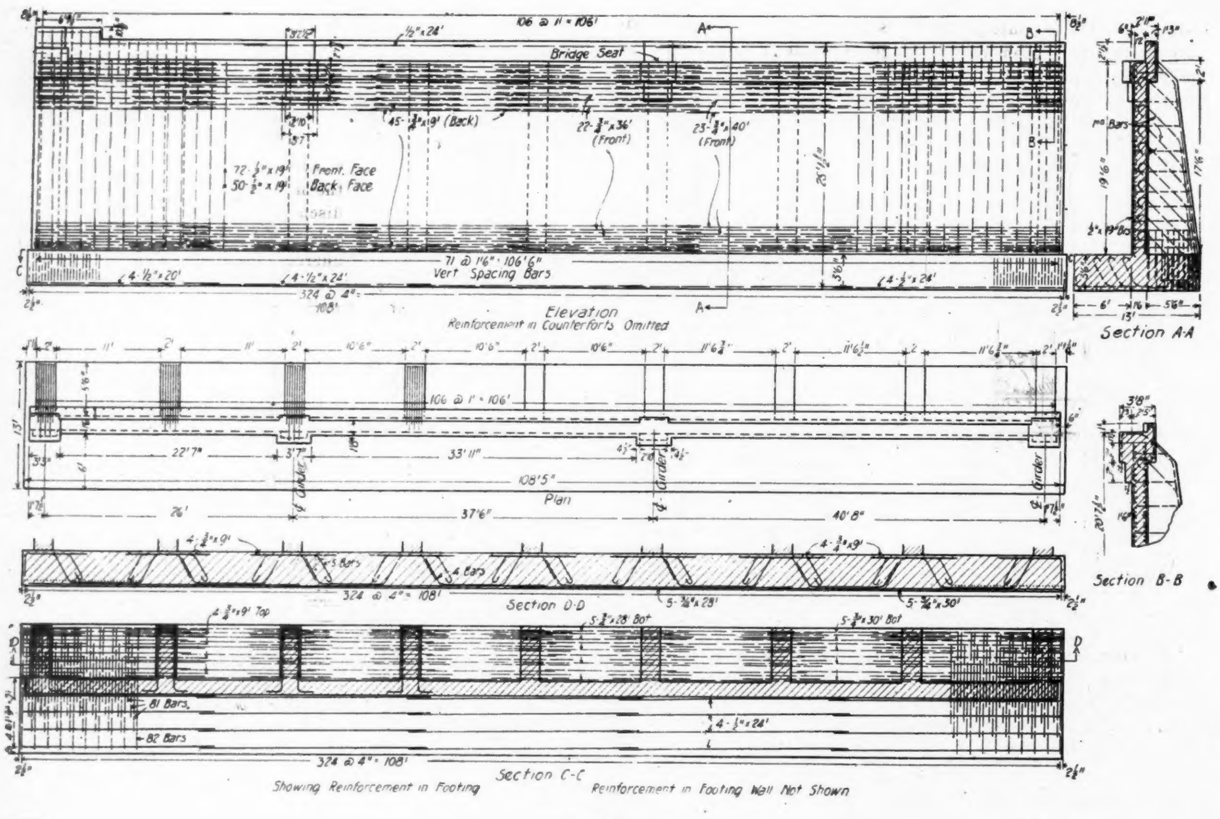
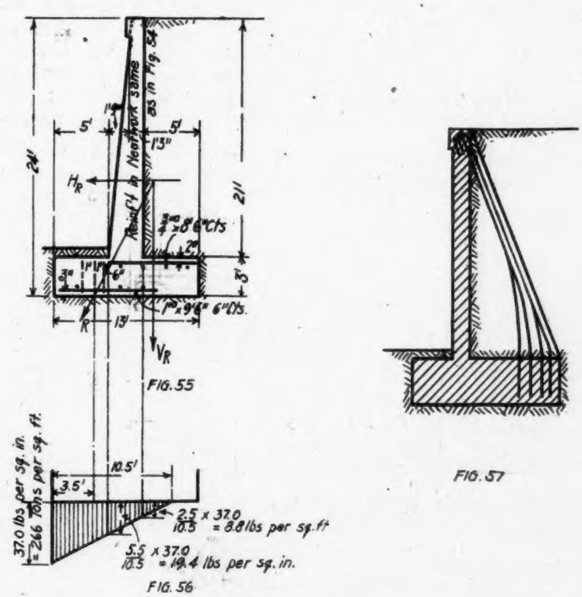


Fig. 58.

terfort as practicable. The practice of distributing the steel in small units all over the tension zone of the counterfort (see Fig. 57) is a very objectionable one, as the steel is liable to be overstressed considerably. This practice is due to a misconception of the action of the counterfort under stress.

The counterfort is a T-beam, and, like all other T-beams, it cannot act as desired unless the compression slab (in this case the front wall) is securely anchored to the stem which is in this case the counterfort. The counterfort acts as support for both the front wall and the heel slab, and the anchorage should be so proportioned as to transmit the reaction of these slabs to the counterfort, both in tension and in bond. Like all T-beams, the shear is generally high in the counterfort, and the provision made for the shearing stresses is, in most cases, insufficient. The same engineer who designs stirrups or bent bars in a girder with an average shear of 100 lbs. per sq. in. with great care so as to insure their effectiveness, will often place horizontal bars near each face of a counterfort which carries the same unit shear. This seems to be a standard detail. In the text books and periodicals, there are hardly any walls to be found where the horizontal bars have been looped around the main tension bars near the back. It is apparent that a straight bar, placed like a spacing or distributing bar, cannot assist greatly in carrying



Figs. 55, 56, and 57.

shear or diagonal tension. Either real stirrups looped around the main bars and spaced close enough to carry the total shear minus the share of the concrete, or bent bars, similar to those used in girders with heavy shearing stresses, should be used.

The shearing stresses are liable to be especially high in walls with short heel (in rock cuts). Figs. 58, a, b, and c, show plan, elevation and section through a retaining wall which is the North abutment of the Market street overhead bridge over the C. M. & St. P. Railroad tracks in Spokane, Wash. A railroad track runs on top of the backfill parallel and close to the wall. The surcharge was, therefore, assumed equal to the weight of 12.5 ft. of earth at 100 lbs. per cubic ft. The following is an analysis of a typical wall of 29 ft. height and 14 ft. 3 in. width of base. The same method of analysis has been used in designing the retaining walls Figs. 58 and 63.

Fig. 59a shows the plan and Fig. 59b the section through the wall which has 1 ft. 6 ins. counterforts 12 ft. centers. Fig. 59c shows the diagram of the earth pressure and live load thrust which are computed on the basis of a natural slope of the backfill of 1½ to 1.

The total horizontal thrust

$$E_1 = \frac{358 + 1{,}187}{2} \times 29 = 22{,}400 \text{ lbs. per lin. ft. of wall.}$$

The center of gravity of E_1 is 11.91 ft. above the base.

The vertical forces are as follows:

$$\begin{aligned} V_1 &= \text{weight of earth fill and surcharge} \\ &= \begin{cases} 9.25 \times 26 \times 100 & = 24{,}050 \text{ lbs.} \\ 9.25 \times 1{,}250 & = 11{,}560 \text{ lbs.} \end{cases} \\ V_2 &= \text{weight of footing} = 14.25 \times 3.0 \times 150 = 6{,}410 \text{ lbs.} \\ V_3 &= \text{weight of wall} = 26.0 \times 1.5 \times 150 = 5{,}850 \text{ lbs.} \\ V_r &= \text{total vertical force} = 47{,}870 \text{ lbs.} \end{aligned}$$

The center of gravity of the vertical forces is 8.65 ft. from the toe of the footing. The resultant of all horizontal and vertical forces intersects the base at a distance of

$$8.65 - \frac{22{,}400 \times 11.91}{47{,}870} = 3.07 \text{ ft.}$$

from the toe.

The soil reaction is distributed over a distance $3 \times 3.07 = 9.21$ ft. from the toe. The maximum toe pressure is 5.2 tons per square foot.

To facilitate the analysis of various horizontal sections, the curve of the shear has been plotted, in Fig. 60, the horizontal ordinate giving the shear at any section. The light line gives the total shear on the section, while the heavy line gives the resultant shear after the subtraction of that portion of the shear which is carried by the main reinforcement owing to its inclined direction. For a discussion of the distribution of the shear in beams with variable sections the reader is referred to Prof. Emil Moersch's Concrete-Steel Construction, 1909 Edition, p. 190. The subtractive quantity, if the additional quantity due to the slight inclination of the compressive stresses is

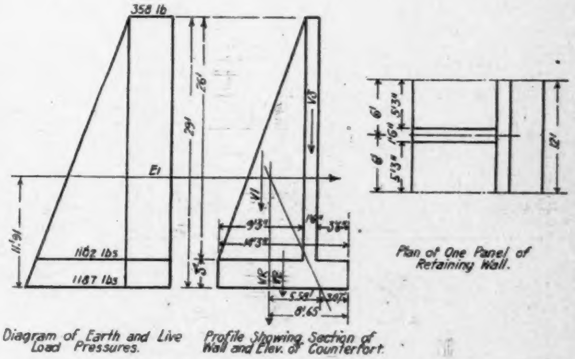


Fig. 59c Fig. 59b Fig. 59a

Figs. 59c, 59b, and 59a.

neglected, is ⅞ T tan α, where T = the internal tensile force acting in the vertical direction.

α = the angle between the vertical and the back of the counterfort.

At the section through the counterfort at the bottom of the neatwork, the moment

$$M = 29{,}490{,}360 \text{ in. lbs.}$$

$$T = \text{Compression} = \text{Tension} = \frac{29{,}490{,}360}{116} = 254{,}200 \text{ lbs.}$$

The compressive fibre stress is determined by the equation

$$\frac{f_c + \frac{11.5}{29.5} f_c}{2} \times 18 \times 12 \times 6 = 254{,}200,$$

to $f_c = 282$ lbs. per sq. in.

The tensile stress in the direction in which the main reinforcement is placed (parallel with the back) is

$$\frac{T}{\cos \alpha} = \frac{254{,}200 \times 27.6}{26} = 269{,}800 \text{ lbs.}$$

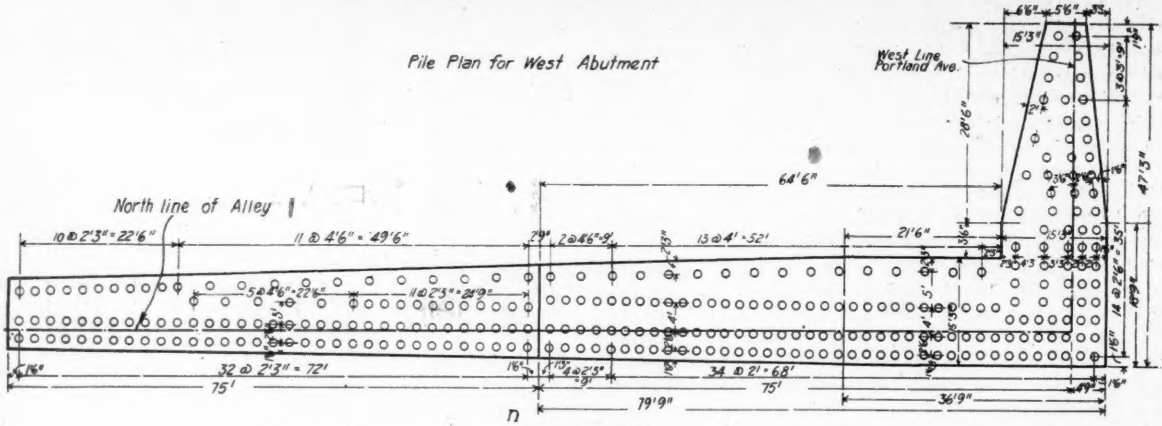


Fig. 62, Pile Plan.

The total shear on the section is

$$\frac{1{,}102 + 358}{2} \times 26 \times 12 = 227{,}800 \text{ lbs.}$$

The reduction of shear due to the batter of the back is

$$254{,}200 \times 7/8 \times \frac{9.25}{26} = 79{,}000 \text{ lbs.}$$

The resultant shear on the section is, then, 227,800 — 79,000 = 148,800 lbs., or, the average unit shear is

$$\frac{148{,}800}{18 \times 123} = 67.5 \text{ lbs. per sq. in.}$$

Similarly the shear is found to be at

3 ft. above the bottom = 22,500 lbs. = 61.5 lbs. per. sq. in.
12 ft. above the bottom = 61,000 lbs. = 46.5 lbs. per sq. in.
15 ft. above the bottom = 34,600 lbs. = 32.0 lbs. per sq. in.
20 ft. above the bottim = 21,800 lbs. = 31.4 lbs. per sq in.
23 ft. above the bottom = 11,070 lbs. = 23.6 lbs. per sq. in.

If the tensile strength of the concrete is neglected, then both the direction and amount of the diagonal tension do not vary between the neutral line and the center of the steel reinforcement.

If α = the angle between the neutral line and the direction of the diagonal tension,

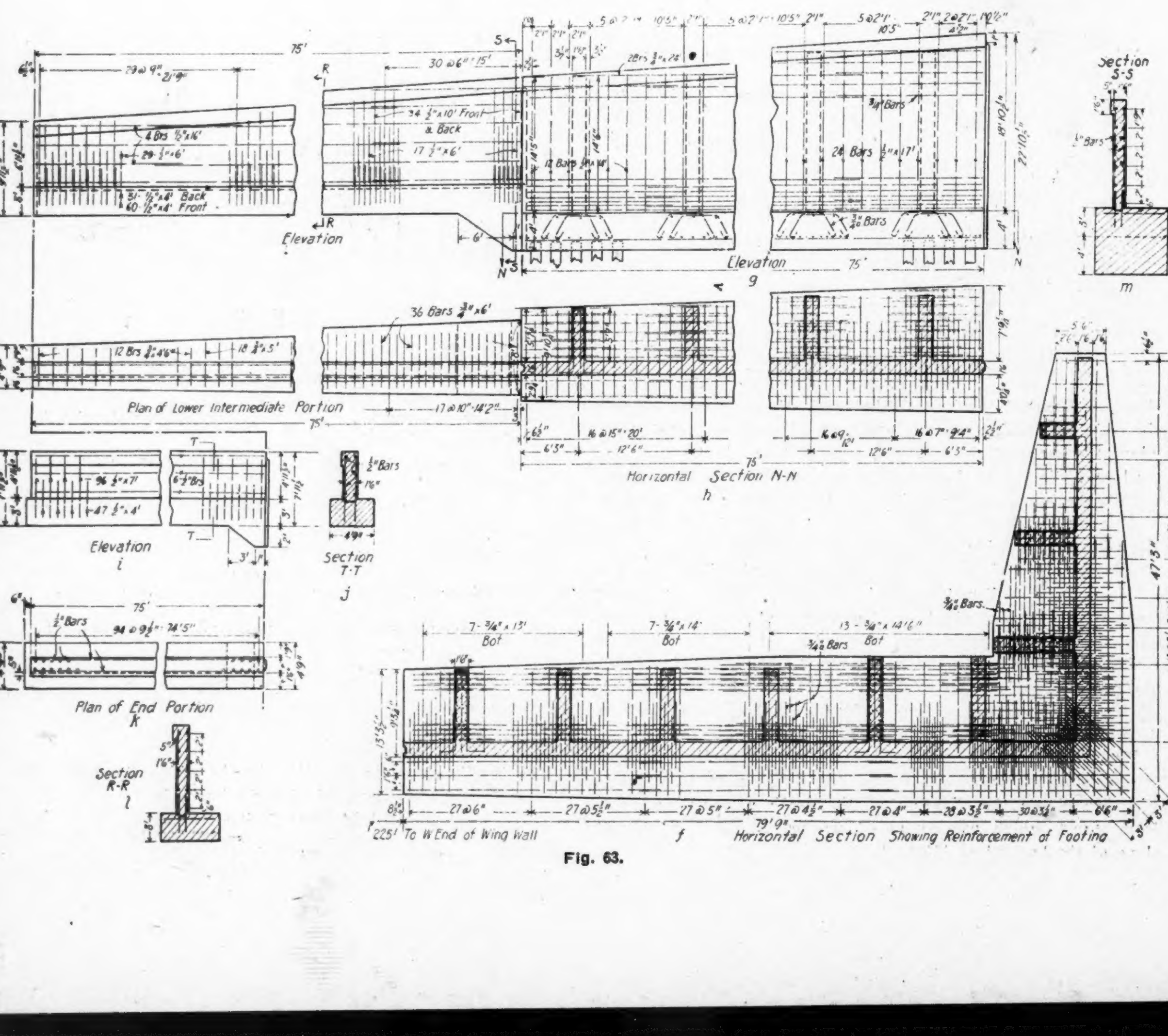


Fig. 63.

v = shearing stress,
f_t = direct tensile stress;
then the direction of the diagonal tension is given by

$$\tan 2\alpha = \frac{2v}{f_t}$$

Between the neutral line and the steel

$$f_t = 0, \text{ whence}$$
$$\tan 2\alpha = \infty,$$
$$2\alpha = 90^\circ,$$
$$\alpha = 45^\circ.$$

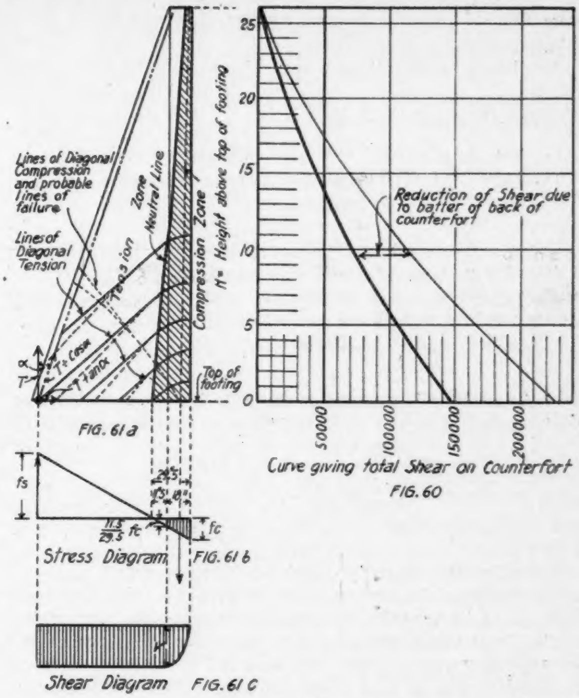
The amount of diagonal tension is determined by the equation

$$D.\,T. = \frac{f_t}{2} + \sqrt{\frac{(f_t)^2}{4} + v^2}$$
$$f_t = 0,$$
$$D.\,T. = v.$$

The diagonal tension in the tension zone on any section equals the average shear at the section, and its direction is 45° with the neutral axis.

Diagonal tension in the compression zone is a curve, and its amount is rapidly diminishing with increasing distance from the neutral line, owing to the influence of the compressive stresses which are substituted in the above formulas as negative tension. Fig. 61a shows the neutral line, the compression and tension zone, and also the lines of diagonal tension and diagonal compression, which latter coincide with the lines of probable failure. The full lines indicate the diagonal stresses if the tensile strength of the concrete is neglected. The influence of the tensile strength of the concrete tends to change the direction of the lines slightly, as indicated by the dotted lines.

Figs. 61b and c are diagrams of compressive and tensile stresses and of shearing stresses, on the horizontal section



Figs. 60, 61a, 61b, and 61c.

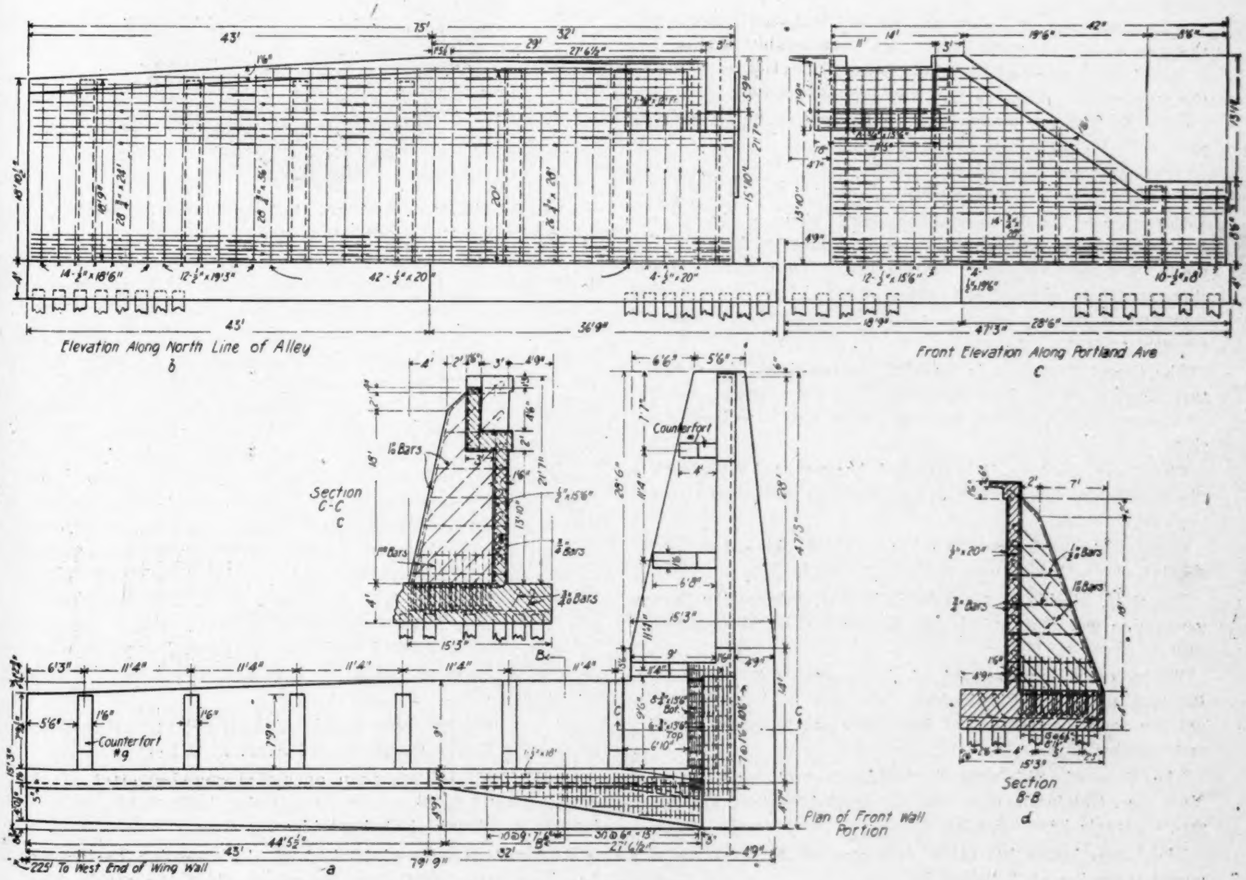


Fig. 63.—(Continuation from Opposite Page.)

through the bottom of the neatwork. The compression on the stem has been neglected, as is usually done in the analysis of T-beams.

As shown before, the average shear at a bottom section

is 67.5 lbs. per sq. in.

at 3 ft. above the bottom it is 61.5 lbs. per sq. in.

Average shear = 64.5 lbs. per sq. in.

The total diagonal tension between these sections

$$\text{D. T.} = \frac{18 \times 36 \times 64.5}{\sqrt{2}} = 29{,}600 \text{ lbs.}$$

Allowing a stress of 12,000 lbs. per sq. in. on the steel, and assuming that the steel will take all tension, the area of steel section required between the two sections is

$$A_{s_1} = \frac{29{,}600}{12{,}000} = 2.4 \text{ sq. in.}$$

If the concrete is assumed to carry 30 lbs. per sq. in. of diagonal tension, then the steel will have to be proportioned for

$$\text{D. T.} = \frac{18 \times 36 \times 34.5}{\sqrt{2}} = 15{,}800 \text{ lbs.}$$

$$A_{s_2} = \frac{15{,}800}{12{,}000} = 1.32 \text{ sq. in.}$$

The other sections are to be investigated similarly.

Fig. 62 shows the reinforcement proposed for this counterfort. The reinforcement in the wall and in the footing has been omitted.

Fig. 63 shows a retaining wall along Portland Avenue and an Alley in Tacoma, Wash. The east end of the wall, facing on Portland avenue, is used as an abutment for the steel structure which carries the C. M. & St. P. tracks over the street. The walls, Fig. 58 and Fig. 63, were designed in the Chicago office of the engineering department of the C. M & St. P. Railroad, Mr. C. F. Loweth, chief engineer; Mr. J. H. Prior, assistant engineer.

Two sections of the wall, Fig. 63, are L-shaped walls, while the two eastern sections, which are considerably higher, are designed as counterfort retaining walls. Attention is called to the web reinforcement in toe, heel and counterfort.

Stability and toe pressure of counterfort retaining walls is practically identical with L-shaped walls.

(To be concluded.)

Reports point to the re-establishment of shops of the Chicago & NorthWestern and the selection of a location between Kenosha, Wis., and Winthrop Harbor, Ill. The present Chicago shops would be abandoned because of lack of room for needed enlargement and the company's inability to purchase additional acreage adjoining them.

The Grand Trunk, it is reported, contemplates the expenditure of $100,000 for improvements about the yards at Nichols. The work, it is reported, will include a new roundhouse and shops.

The Great Northern, it is reported, has awarded a contract to the Widell Co. for about $300,000 worth of tunnel and bridge work in Montana.

Gulf, Colorado & Santa Fe has received bids on a $25,000 six-stall engine house to be erected at Temple, Tex.

The Gulf, Florida & Alabama, is is said, will erect a passenger station and office building at Pensacola, Fla., at an expenditure of about $50,000.

The proposed improvement of the Louisville & Nashville at Boyle, a suburb of Birmingham, Ala., will, it is reported, involve a total expenditure of $1,000,000 and include a foundry and machine shop.

The Missouri, Oklahoma & Gulf will erect main shops at Muskogee, Oklahoma, at a cost of about $200,000. The necessary contracts have been let.

The Pennsylvania has taken estimates for the erection of a pumping station at Hillside, Pa.

Personals

Operating.

S. S. Hoff has been appointed superintendent of the Altoona Juniata & Northern Ry. at Altoona, Pa., succeeding C. H. Kipple.

R. N. Begien, formerly assistant general superintendent, has been appointed general superintendent of the Baltimore & Ohio Southwestern R. R., exclusive of the Cincinnati terminals, office at Cincinnati, O. The authority of H. B. Voorhees, general superintendent, has been extended over Cincinnati, Hamilton & Dayton Ry., and the Cincinnati terminal division, office at Cincinnati, O. J. B. Carothers has been appointed assistant general manager of the B. & O. S. W. R. R. and the Cincinnati Hamilton & Dayton Ry., succeeding F. D. Batchellor.

C. A. Plumly has been appointed assistant general superintendent of the B. & O. S. W. R. R. at Cincinnati, succeeding E. W. Scheer. He was born October 15th, 1876, and became a telegraph operator while wearing knee pants, and performed his first service for the Cincinnati, Washington & Baltimore R. R. November 1st, 1887, holding various positions as agent and operator with the above company, later the B. & O. S. W. R. R. Co., until June 1st, 1903, when he was appointed extra train dispatcher at Chillicothe, Ohio, and later made regular dispatcher. On October 20th, 1905, he was made night chief dispatcher at Chillicothe, was promoted to day chief train dispatcher September 10th, 1907, and made division operator with headquarters at Cincinnati, Ohio, July 31st, 1910. He was appointed trainmaster, Indiana division, with headquarters at Seymour, Ind., March 1st, 1912; appointed assistant superintendent telegraph B. & O. S. W. and C. H. & D. Ry. January 1st, 1913, with headquarters at Cincinnati, Ohio. June 1st, 1913, he was appointed assistant to general superintendent B. & O. S. W. R. R. and C. H. & D. Ry., with headquarters at Cincinnati, Ohio.

C. A. PLUMLY, Assistant to General Superintendent. Baltimore & Ohio Southwestern R. R.

A. A. Kopp has been appointed assistant general manager of the Big Sandy & Cumberland R. R. at O'Keefe, W. Va.

E. S. McDaniel has been appointed superintendent of the Birmingham & Southeastern Ry. at Union Springs, Ala., succeeding W. M. Blount, elected president.

R. Armstrong, superintendent of the Canadian Pacific Ry., has been transferred from Saskatoon, Sask., to Souris, Man.

E. W. Du Val, superintendent, has been transferred from Souris, Man., to Saskatoon, Sask., succeeding Mr. Armstrong. H. D. Grant has been appointed acting general superintendent at St. John, N. B., succeeding Wm. Downie, granted leave of absence.

John McCraw, formerly acting superintendent, has been appointed superintendent of the Central Vermont Ry.

E. R. Glidden has been appointed superintendent of the Chicago & Alton Ry. at Evansville, Ind., succeeding J. O. Bell, who has accepted service with another company.

S. A. Morrison, formerly trainmaster, has been appointed superintendent of the Chicago & North Western Ry. at Chicago, succeeding F. O'Brien, transferred.

F. B. Mitchell has been appointed superintendent of the Cincinnati, Hamilton & Dayton Ry., at Dayton, O., succeeding J. J. Corcoran.

John Maney, formerly general superintendent, has been elected vice-president and general manager of the Clinton & Oklahoma Western Ry., at Clinton, Okla.

E. B. Mitchell has been appointed assistant superintendent of the Colorado & Southern Ry. at Cheyenne, Wyo., succeeding W. L. Smith.

T. H. Hayden has been appointed general manager of the Cumberland R. R. at Artemus, Ky., succeeding B. H. Milner.

C. E. Hall has been appointed general manager of the Dardanelle & Russellville R. R. at Russellville, Ark.

M. F. Figgatt has been appointed general manager of the Durham & South Carolina R. R., office at Durham, N. C.

R. C. Watkins has been appointed acting superintendent of the Galveston, Harrisburg & San Antonio Ry. at San Antonio, Tex., succeeding J. E. Taussig.

James Bain, formerly superintendent, has been appointed general superintendent of the Halifax & Southeastern Ry., at Halifax, N. S.

J. Burns has been elected vice president and general manager of the Jonesboro, Lake City & Eastern R. R., office at Jonesboro, Ark., succeeding W. H. Smith.

J. F. Sugrue has been appointed superintendent of the Lake Charles & Northern R. R. at De Ridder, La., succeeding J. K. Foley.

Orange Richardson has been appointed general manager of the Laurel Fork Ry., succeeding Evan Jones, office at Hampton, Carter Co., Tenn.

J. W. Knightlinger, formerly assistant superintendent, has been appointed superintendent of the Louisiana Western R. R. and Morgan's Louisiana & Texas R. R., at Lafayette, La., succeeding L. Mims.

A. C. Lee has been appointed general manager of the Manistee & Repton Ry. at Monroeville, Ala., succeeding J. A. Kauffman.

J. C. Dougherty has been appointed general manager of the Milltown Air Line Ry. He entered railway service in 1896, with the Georgia R. R., where he held the positions of operator and agent at various locations. In 1899 he entered the service of the Georgia Southern & Florida Ry., where he held the positions of operator, bill clerk, cashier, and joint freight agent. In 1902-3 he was employed as agent and later commercial agent of the Tipton, Thomasville & Gulf Ry., and in 1903-4 was freight agent of the Atlanta, Birmingham & Atlantic Ry., and the latter part of 1904 he was rate clerk of the Brunswick & Birmingham Ry. In 1904-5 he was agent of the Valdosta Southern Ry., and during 1905-6 was appointed auditor and then general freight and passenger agent. He was chief clerk to traffic manager, Georgia & Florida Ry., 1906-7, auditor of the Savannah & Northern Ry., 1907-9, auditor of the Valdosta, Moultrie & Western Ry., 1909-12, and retired on account of ill health in 1912. His appointment as general manager, as noted above, was effective May 21, office at Milltown, Ga.

F. Ringer has been appointed superintendent of the Missouri, Kansas & Texas Ry. at Muskogee, Okla.

A. J. Alexander, superintendent of the Missouri Pacific Ry., has been transferred from Sedalia, Mo., to Pueblo, Colo., succeeding T. A. Shea, transferred to McGehee, Ark., succeeding C. M. Andrews. Phil Carroll has been appointed superintendent at Poplar Bluff, Mo., succeeding J. Cannon.

B. B. Tolston has been appointed division superintendent of the Mobile & Ohio R. R. at Murphysboro, Ill., succeeding E. W. Moore.

W. E. Brisbin, formerly superintendent, has been appointed general superintendent of the National Rys. of Mexico, at Tierra Blanca, V. C., Mex. S. D. Canales has been appointed superintendent at Monterey, N. L., succeeding J. C. Doria.

H. M. Blon has been appointed superintendent of the New Mexico Midland Ry., office at San Antonio, Tex.

W. A. Pease, formerly superintendent, has been appointed general superintendent of the Nezperce & Idaho R. R., office at Lewiston, Ida.

J. D. Patterson has been appointed general superintendent of the Panama R. R., office at Colon, Panama. He was first employed in the capacities of engineer, passenger conductor, roadmaster, yardmaster, trainmaster and station master of the Atlanta joint terminals. He was later appointed superintendent on the Mobile, Jackson & Kansas City R. R. He held the position of general superintendent of the Atlanta joint terminal till May 19, 1913, when he accepted the position as noted above.

A. G. Whittington has been appointed superintendent of the International & Great Northern Ry. at San Antonio, Tex.

E. H. Green, Jr., has been appointed general manager of the Peach River Lines at Beaumont, Tex., succeeding C. W. Hole.

C. G. Stephens has been elected vice president and general manager of the Pelham & Havana R. R., office at Cairo, Ga.

J. J. Corcoran has been appointed superintendent of the Pere Marquette R. R. at Detroit, Mich., succeeding H. O. Halsted, assigned to other duties.

E. L. Page has been appointed general manager of the Portland & South Eastern R. R. at Portland, Ark.

M. Blizard, formerly superintendent, has been appointed general manager of the St. Joseph Valley Ry., office at Elkhart, Ind.

F. O'Brien, formerly superintendent of the Chicago & North Western Ry., has been appointed superintendent of the St. Louis, Peoria & North Western Ry., office at Pekin, Ill.

Lucius Laudie, formerly auditor, has been appointed general manager of the Salt Lake & Mercur R. R. at Salt Lake City, Utah.

W. J. Parks has been appointed superintendent of the Tennessee & North Carolina R. R. at Newport, Tenn., succeeding A. J. McMahan.

W. M. Lynch, formerly trainmaster, has been appointed superintendent of the Texas & Pacific Ry. at Big Spring, Tex., succeeding A. G. Whittington.

W. H. Raymond has been appointed superintendent of the Tooele Valley Ry. at Tooele, Wash., succeeding L. T. Sicka.

A. W. Laird, formerly assistant treasurer, has been appointed general manager of the Washington, Idaho & Montana Ry. at Potlatch, Ida., succeeding W. M. Deary, deceased.

Peter E. Stryker has been appointed superintendent of the Wharton & Northern R. R., office at Wharton, N. J.

Engineering.

F. L. Guy, division engineer of the Atchison, Topeka & Santa Fe Ry., has been transferred from Arkansas City to Emporia, Kan., succeeding M. C. Blanchard, promoted. H. J. Moore has been appointed division engineer at Arkansas City, succeeding Mr. Guy.

J. E. Willoughby has been appointed assistant chief engineer of the Atlantic Coast Line R. R. at Wilmington, N. C. He graduated from the University of Alabama in 1892 with the degree of Bachelor of Engineering, and began railway work in 1887 as rodman on the Birmingham Mineral R. R. He worked in the engineering and land departments of the Louisville & Nashville R. R. from August, 1887, to April, 1900, exclusive of some three years which were spent at the University of Alabama. In 1900 he was appointed assistant chief engineer of the L. & N. R. R. new lines in Alabama, and in 1901 he was appointed engineer of construction of the Alabama and Florida division. In 1902 he was made division engineer of the La Follette & Jellico R. R., an L. & N. subsidiary, and in 1903-4 was chief engineer of the Knoxville, La Follette & Jellico R. R. From 1905 to 1912 he was engineer of construction of the Louisville & Nashville R. R., including several subsidiary lines. He was chief engineer of the National Rys. of Haiti and of the Carribean Construction Co. in 1912-13. June 1, 1913, he was appointed assistant chief engineer of the Atlantic Coast Line R. R., as noted above, office at Wilmington, N. C. He is a member of the American Society of Civil Engineers and of the American Railway Engineering Association. His experience has covered new construction varying in cost from $10,000 to $350,000 per mile, and the reconstruction of over 1,000 miles of railway.

E. D. Jackson has been appointed division engineer of the Baltimore & Ohio R. R. at Philadelphia. He graduated from Virginia Military Institute in 1902 and entered the service of the B. & O. R. R. as rodman in 1902. He was appointed assistant division engineer in August, 1906, and assistant engineer in the general offices in January, 1907. He was appointed division engineer of the Chicago division in April, 1909, assistant engineer, operating department, in March, 1910, and assistant engineer in the maintenance of way department in November, 1911. His present position as division engineer took effect May 1, office at Philadelphia, Pa.

A. T. Fraser has been appointed district engineer of the Canadian Northern Ry. at Edmonton, Alta.

F. I. Cabell, chief engineer of the Chesapeake & Ohio Ry., has been appointed chairman of the valuation committee, and the duties of the chief engineer's office will be performed by W. F. Steffens, assistant chief engineer, until further notice.

P. V. Brown has been appointed assistant engineer of the Chicago & Alton Ry. at East St. Louis, Ill.

J. O. Bell has been appointed superintendent of the Chicago & Eastern Illinois R. R. at Salem, Ill., succeeding G. H. Trenary, transferred to the Chicago division, office at Danville, Ill.

C. Brannon, formerly assistant engineer, has been appointed assistant chief engineer of the Chicago & Eastern Illinois R. R., office at Chicago, Ill. R. R. Wilson has been appointed assistant engineer at Evansville, Ind., succeeding Mr. Brannon.

L. J. Putnam, who was appointed principal assistant engineer of the Chicago & North Western Ry., as announced in the June issue of *Railway Engineering,* was born at Manchester, Ia., February 17, 1878. He graduated from Cornell College, Mt. Vernon, Ia., in 1905, in the civil engineering course, and began railway work with the Illinois Central R. R. in 1898. In 1899 he accepted a position as instrument man on the C. & N. W. Ry. He was appointed assistant engineer on construction in 1901, and served in that capacity on various divisions till March, 1906, when he was appointed acting division engineer. In March, 1907, he was appointed assistant resident engineer, serving in this capacity at various locations till April, 1912. In this capacity he had charge of terminal improvements, construction of a bascule bridge, track elevation, construction of ore dock, and a construction division on the Milwaukee-Sparta line. He was appointed division engineer of the East Iowa, West Iowa, Iowa and Minnesota divisions in April, 1912, and promoted to principal assistant engineer May 15, 1913, office at Chicago.

B. B. Shaw, assistant engineer of the Chicago, Rock Island & Pacific Ry., has been transferred from El Reno to McAlester, Okla.

W. S. Burnett has been appointed district engineer in charge of construction of the Cleveland, Cincinnati, Chicago & St. Louis Ry. at Middletown, O. A. M. Turner has been appointed district engineer of construction at Indianapolis, Ind.

Thomas B. Kennedy, who has been appointed engineer of the Cumberland Valley, effective June 17, was born on September 22, 1870, at Chambersburg. He graduated from Chambersburg Academy in 1887, and then took an engineering course at Lafayette College, and at Princeton University. He began railway work in October, 1890, as a rodman and instrument man on the Great Northern, and went to the Cumberland Valley in November, 1892, as a clerk in the auditor's office, and later was transferred to the superintendent's office. From February, 1894, to January of the following year he was draughtsman and instrument man in the maintenance of way department of the same road, and then was appointed assistant supervisor. In May, 1903, he was made supervisor of division B, and later was transferred in the same capacity to division A. He was appointed freight trainmaster in November, 1906, and two years

L. J. PUTNAM, Principal Assistant Engineer. Chicago & North Western Ry.

later was made general trainmaster. In July, 1911, he was appointed assistant to engineer in the maintenance of way department, which position he held at the time of his recent appointment. His office is at Chambersburg, Pa.

W. H. Mansfield has been appointed assistant engineer of the Delaware & Hudson Co. at Albany, N. Y.

V. D. Simar has resigned as chief engineer of the Duluth, South Shore & Atlantic Ry., and all matters pertaining to engineering, bridges and buildings are being handled by E. R. Lewis, assistant to general manager, Duluth, Minn.

E. D. Sabine has been appointed terminal engineer of the Grand Central Terminal Ry., office at New York. He was born in 1874 at Windsor, Vt. He received his education in the public schools in Colorado Springs, Colo., and Maldon, Mass., and graduated from Tufts College in 1896, receiving the degree of B. S. in civil engineering. After a year in the real estate business, he commenced engineering with the Boston Pneumatic Transit Co. as an inspector of the pneumatic mail tubes. The following year he was made assistant engineer in charge of the office for the same company. In 1899 the American Pneumatic Service Co. was organized and took over the Boston Pneumatic

Transit Co., and he was then appointed chief engineer of both corporations. This position he held until 1905, during which time he had charge of the installation of the mail tube service in Boston and the first installations in Chicago and St. Louis. In the spring of 1905 he entered the service of the New York Central & Hudson River R. R. as squad chief in charge of estimates and miscellaneous work on the Electric Zone. The following fall he was transferred to the Grand Central Terminal improvements as squad chief on miscellaneous design. In August, 1906, he was appointed assistant engineer in charge of inspectors in the field, and on February 1, 1908, appointed first assistant engineer in charge of all the field engineering; this position he held until June 1, 1913, when he was appointed terminal engineer, Grand Central Terminal improvements.

C. B. Brown has been appointed chief engineer of the Intercolonial and Prince Edward Island Rys., office at Moncton, N. B.

F. C. Merrell has been appointed chief engineer of the Grand Junction & Grand River Valley Ry., office at Grand Junction, Colo.

J. B. Allen has been appointed superintendent of construction of the International Rys. of Central America at San Miguel, Salvador.

W. L. Morse, formerly engineer of the Grand Central Terminal Ry., has been appointed chief engineer of the Jacksonville Terminal Co., office at Jacksonville, Fla.

C. Yoder, formerly assistant engineer, has been appointed engineer of track of the Lake Shore & Michigan Southern Ry. at Cleveland, O.

J. P. Ramsey, who has been appointed chief engineer of the Lorain, Ashland & Southern Ry., as announced in the June issue of *Railway Engineering*, began work in 1904 as rodman on the construction of the Union Electric Light & Power plant at St. Louis, Mo. He attended college fall of 1904 to February, 1907, and was rodman on the Lorain & Ashland R. R., February, 1907, to July 1907; rodman Kansas City, Mexico & Orient on construction work in the State of Sinaloa, Mex., July, 1907, to December 15, 1907; assistant topographer New York, Pittsburgh & Chicago R. R., January, 1908, to May, 1908; topographer on the same work till November, 1909; assistant engineer of the same work till December, 1900; assistant engineer maintenance of way Ann Arbor R. R., January, 1911, to April 24, 1912. He was chief engineer of the Lorain, Ashland & Southern Ry. and the Ashland & Western R. R. April 25, 1912, to April 13, 1913, and was appointed chief engineer of the Lorain, Ashland & Southern R. R., a combination of the Lorain Industrial R. R., the Lorain, Ashland & Southern Ry. and the Ashland & Western Ry., April 13, 1913.

C. E. Wright has been appointed division engineer of the Missouri, Kansas & Texas Ry. at Muskogee, Okla., succeeding F. H. Van Craenbroeck.

E. D. Bischoff has been appointed assistant engineer of the Missouri Pacific Ry. at St. Louis, Mo. C. L. Haydock has been appointed assistant engineer at St. Louis, Mo., succeeding F. K. Bennett. W. M. Nystune has been appointed assistant engineer at St. Louis, Mo. P. J. Simons has been appointed assistant engineer at St. Louis, Mo.

J. M. Torr, formerly roadmaster, has been appointed division engineer maintenance of way of the New York, New Haven & Hartford R. R. at Providence, R. I.

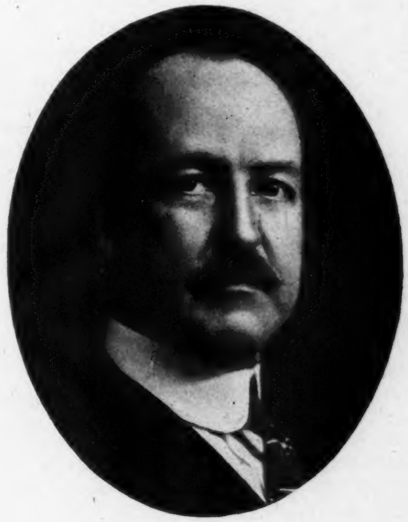
T. J. Skillman, who has been appointed division engineer of the New York, Philadelphia & Norfolk R. R., entered the service of the Pennsylvania R. R. as rodman in 1899, and in 1902 was transferred to the principal assistant engineer's office as transitman. He was promoted to assistant supervisor in 1903, which position he held on various divisions. He was appointed supervisor of the Pittsburgh division in 1905, and was appointed supervisor of the Pennsylvania Tunnel & Terminal Ry. in 1909, in charge of track construction on the Pennsylvania terminal. His promotion to division engineer of the N. Y. P. & N. R. R. was effective June 16.

W. G. Bowen, division engineer of the National Rys. of Mexico, has been transferred from Monterey, N. L., to San Luis Potosi, S. L. P., in place of J. C. Galbreath, transferred to Guadalajara, Jal., Mex., who succeeds Edward Sabathe.

J. H. Sandmaker has been appointed chief engineer of the Ohio Electric Ry. at Springfield, succeeding Gaylord Thompson.

A. M. Lupfer, chief engineer of the Oregon Trunk Ry. and the Spokane & Inland Empire R. R., has been also appointed chief engineer of the Oregon Electric Ry. His office is at Portland, Ore.

R. P. Waller has been appointed engineer maintenance of way of the Otsego & Herkimer R. R. at Cooperstown, N. Y., succeeding C. S. Lee. He graduated from Williams College in 1907 and from Massachusetts Institute of Technology in 1910, civil engineering course. He entered railway service as rodman on the Pennsylvania R. R. in 1910.



C. A. PRESTON,
Valuation Engineer Pennsylvania R. R.

Joseph T. Richards, formerly chief engineer maintenance of way of the Pennsylvania R. R., has been appointed consulting engineer maintenance of way. A. B. Clark, formerly principal assistant engineer of the Philadelphia, Baltimore & Washington R. R., has been appointed assistant engineer maintenance of track, Penn. R. R., office at Philadelphia, Pa. George C. Koons, formerly engineer of the Cumberland Valley R. R., has been appointed assistant engineer maintenance of way, Penn. R. R., with jurisdiction over bridges and track, office at Philadelphia, Pa.

Cecil A. Preston has been appointed valuation engineer of the Pennsylvania R. R., office at Philadelphia, Pa. After graduating from the Polytechnic College of Philadelphia in 1872, he entered actively into his profession of civil engineer, being engaged until June, 1877, as transitman and engineer in charge, upon railway surveys, location and construction of various projected lines upon railroads in operation in southern New York, New Jersey, eastern Pennsylvania and Maryland. From June to December, 1877, he was employed on topographical surveys of northeastern Philadelphia under the direction of John H. Dye. On January 2, 1878, he associated with the "Collins Expedition" in the construction of the Madeira & Mamore Ry. in the Province of Matto Grosso, Brazil, serving as an engineer, returning to the United States in 1879. He was then sent to England as a witness in a suit against the Madeira & Mamore Ry. In May, 1879, he entered the service of the Pennsylvania R. R. under the direction of Mr. C. S. d'Invilliers on surveys for the Catonsville R. R. and for changing alignment and grades of

the West Penn. R. R. On March 1, 1880, he was transferred to Baltimore, Md., as a transitman and was appointed assistant supervisor of Baltimore section of the Northern Central Ry., September 1, 1880. In November, 1880, he accepted the position of principal assistant engineer of the Mexican National Construction Co., was assigned to the Pacific Coast division, and after active service of 18 months in Mexico upon preliminary surveys, location and construction, returned to the United States. On April 10, 1882, he again entered into the service of the Northern Central Ry. as assistant supervisor and located at York. Mr. Preston has been in continuous service of the Pennsylvania R. R. since that time. He was promoted from assistant supervisor at York to supervisor Section No. 1, August 1, 1882, and transferred from that section to Baltimore in 1883, which position he occupied until January 1, 1890, when he was appointed assistant engineer of the Baltimore division. On March 1, 1893, he was promoted to principal assistant engineer of the Philadelphia & Erie R. R. division and the Northern Central Ry., which position he held until July 1, 1900, when he was promoted to superintendent of the Elmira & Canandaigua divisions at Elmira, N. Y. He remained at Elmira until April 1, 1902, when he was made superintendent of the Eastern and Susquehanna divisions of the same road, with headquarters at Williamsport, Pa., in which position he remained until June 1, 1903, when he was appointed superintendent of the Middle division of the Pennsylvania R. R. at Altoona, where he remained until June 16, 1913, when he was promoted to valuation engineer of the Pennsylvania R. R., located at Philadelphia, Pa.

D. T. Easby, formerly supervisor, has been appointed division engineer of the Pennsylvania R. R. at Oil City, Pa., succeeding H. H. Russell, transferred to Altoona, Pa. F. W. Smith, Jr., division engineer, has been transferred from Pittsburgh, Pa., to Jersey City, N. J. C. E. Zortman, formerly supervisor, succeeds Mr. Smith as division engineer at Pittsburgh, Pa.

C. J. Rist has been appointed assistant engineer maintenance of way of the Pere Marquette R. R., office at Detroit, Mich. J. E. Johnson has been appointed division engineer at Saginaw, Mich., succeeding A. B. Ziegwied.

C. I. Leiper, formerly division engineer of the Pennsylvania R. R., has been appointed principal assistant engineer of the Philadelphia, Baltimore & Washington R. R., office at Wilmington, Del., succeeding A. B. Clark, promoted.

C. V. Bucher, formerly assistant division engineer, has been appointed assistant engineer of the Toledo & Ohio Central Ry., office at Columbus, O. E. G. Lane has been appointed assistant division engineer at Bucyrus, O., succeeding Mr. Bucher.

Bridges and Buildings.

P. E. Littles has been appointed master carpenter of the Chicago, Burlington & Quincy R. R. at St. Joseph, Mo., succeeding W. Hurst, effective June 1.

P. Gray has been appointed bridge superintendent of the Cincinnati, Georgetown & Portsmouth R. R., at Cincinnati, O., succeeding J. Smith.

G. W. Kinney has been appointed master carpenter of the Denver & Rio Grande R. R. at Salt Lake City, Utah, effective May 16.

J. E. Clements has been appointed superintendent of bridges and buildings of the Detroit, Toledo & Ironton Ry. at Springfield, O., succeeding Jacob Confer.

G. H. Smith has been appointed acting inspector of bridges of the Intercolonial Ry. of Canada, in place of A. E. Killam, granted leave of absence.

W. B. Schuessler, supervisor of bridges and buildings of the New York, New Haven & Hartford R. R., has been transferred from New Haven to Waterbury, Conn. J. J. Wishart has been appointed supervisor of bridges and buildings at Hartford, Conn.

L. H. Metcalf has been appointed superintendent of bridges and buildings of the Tallulah Falls Ry. at Cornelia, Ga., succeeding J. A. Walker.

New Books

PROCEEDINGS, ROADMASTERS' ASSOCIATION, C. M. & ST. P. RY. Paper, 4x6½ in., 96 pages, 3 illustrations. W. H. Kofmehl, secretary and treasurer, roadmaster C. M. & St. P. Ry., Elgin, Ill.

This book contains the reports and verbatim discussions of the Chicago, Milwaukee & St. Paul Ry. Roadmasters' Association convention held at the Republican House, Milwaukee, Wis., November 20 and 21, 1912. The subjects reported on and discussed at this meeting were (1) type and length of rail joints and advisability of using non-slotted rail fastenings; (2) elevation on curves; (3) the plates, type, size, etc.; (4) track foremen; (5) track drills; (6) proper reason to employ extra track laborers; (7) type and economy of section motor cars; (8) size of ties for side tracks; (9) laying rails around rails; (10) advantage of a machine for relaying rail; (11) rail joints, manganese frogs, renewing tie plates while relaying rail, best and most economical type of switch stand, and other questions on track work.

The reports and discussions on these subjects are quite long and show study and observation which should be valuable to all track men. The discussions on certain makes of track tools and machines are frank and open, and therefore contain some data of a kind which is usually difficult to obtain.

PROCEEDINGS OF THE AMERICAN RAILWAY ENGINEERING ASSOCIATION, FOURTEENTH ANNUAL CONVENTION. Size 6x9 inches; 1,700 pages; numerous diagrams, tables and half-tone illustrations. Paper, $6; cloth, $6.50; half morocco, $7. E. H. Fritch secretary, Karpen Bldg., Chicago.

The work of this association has become so well known, even in its comparatively short existence, as to need very little introduction. The association is maintaining a steady, rapid growth, both in numbers, in volume of subject report, and in the quality of these reports.

One cannot help but be impressed with the volume of this report, and upon careful perusal still more impressed by the thoroughness, painstaking and well-directed efforts shown in them. As an instance of the increasing attention being given these reports by the committees, it is only necessary to state that the meeting in 1913 was adjourned a half day earlier, according to program, than in 1912. As much or more work was covered, however, due to more careful and accurate preparation of reports.

A comprehensive review of this volume, containing as it does the very meat of advanced practice, would occupy more space than can be spared for this purpose. Some of the subjects, however, deserve special mention.

The work of the rail committee after an exhaustive study has finally resulted in specifications which cannot help but put rails on a higher basis as regards uniformity and quality. That the highest officials of the railways recognize the work of this committee is proven by the fact that several conferences have been held between railway presidents and the steel companies, looking toward the adoption of these specifications in the rolling of all rails. Although to date no steel company has rolled rails strictly to these specifications, they have complied with many of the requirements at some mills, and thereby materially bettered the quality of their product.

After many discouragements, the Committee on Economics of Railway Location was able to draw some definite conclusions and make recommendations. The premises underlying this subject are so inexact that it has been extremely difficult to correlate the data into consistent and reliable shape for practical use. The Committee, however, has made some very great strides in the subject, and the data given cannot help but be of great value to any railway engineer, especially any one directly concerned in the subject.

The report of the Committee on Yards and Terminals shows the results of a comprehensive study on this subject, and the methods of charting conditions at a terminal are, we believe, some of the most usable and valuable information gotten out by the association.

After many attempts the Committee on Signals and Interlocking agreed on a report for signal fundamentals, which will undoubtedly, and rightly, become the basis of signal practice in this country. The Building Committee report is very extensive and comparative information on types of roofing should be of great value.

Due to the great differences in opinion, the Committee on Rules and Organization confined its attention mostly to rules. The need for better organization and the false impression regarding the importance of this subject, make it one worthy of the most extensive study.

No railway engineer can afford to ignore the information published in these Proceedings. They should form, at the very least, the basis of studies resulting in the best practice, and in many subjects they show absolutely the best practice.

PROCEEDINGS, NINTH ANNUAL MEETING, AMERICAN WOOD PRESERVERS' ASSOCIATION. Paper, 6x9 in., 500 pages, illustrated. F. J. Angier, secretary-treasurer, Mt. Royal Station, Baltimore, Md.

This volume contains the papers and discussion thereon, as presented to the convention at Hotel Sherman, Chicago, January 21, 22, and 23. This association is constantly growing in membership and importance, as is attested by this volume, which contains more valuable information than any previously issued.

A complete list of papers published in this book would be too extensive to enumerate here. Suffice it to say that the subjects treated cover a very wide range of practical and theoretical features of the wood preserving industry.

Professor Samuel J. Record's paper on "Sap in Relation to the Properties of Wood," deserves special mention because it upsets the practical or common ideas of the behaviour or relative amount of sap in growing timber in the winter and in the summer. Such information as this, establishes a firm basis for modern practice. A thorough knowledge of the structures of different kinds of timber, of the behaviour of sap, etc., is essential to those studying or practicing timber preservation.

SELECTED STANDARD SPECIFICATIONS FOR STEEL AND STEEL PRODUCTS IN ENGLISH, GERMAN, FRENCH, AND SPANISH. Published by the American Society for Testing Materials. Cloth 6x9. Price —.

This book is a compilation of twenty standard specifications for steel products selected for purposes of publication in English, German, French and Spanish from among the fifty-three standard specifications of the society in the 1912 year-book. These specifications were reprinted in this form in order to make them known and of value in foreign countries, and also in pursuance of a resolution adopted by the International Association for Testing Materials, for the dissemination of information in regard to the modifications in the specifications in the different countries, with a view of making the preparation of international specifications a less difficult matter.

The specifications given include those for Bessemer steel rails; Open-hearth steel rails; Open-hearth girder and high Tee rails; Steel splice bars; Structural steel for bridges; Structural nickel steel; Structural steel for buildings; Structural steel for ships; Boiler and firebox steel; Boiler rivet steel; Steel axles; Heat-treated carbon steel axles, shafts and similar objects; Forged and rolled, forged or rolled solid carbon-steel wheels for engine truck, tender and passenger service, and also for freight car service; Steel tires; Steel forgings; Steel castings and three sets of specifications for locomotive materials.

This is a very valuable collection of specifications and should be in the hands of every engineer. They are the result of the combined experience and study of a committee with a membership of 89, including the men most prominent among the consuming and manufacturing interests of the steel industry, and can therefore be considered as the best obtainable. The use of standard specifications of all kinds is gradually becoming more general and it is hoped that this book will aid in bringing about the universal use of such specifications.

STEEL DESIGNING. By Edward Godfrey, M. Am. Soc. C. E. Being Structural Engineering Book III. Leather, 4x7 in. 492 pages. Many text figures and drawings. Published by the author, Monongahela Building, Pittsburgh. Price, $2.50.

This book, the third of a series on structural engineering, is intended to be of use to all classes of men who have to do with structural steel, including the student, inspector, draftsman, instructor, designer and erector. The idea in mind is to enable these various classes to familiarize themselves with one another's work, since such knowledge is necessary in order that the finished structure be correctly designed and constructed.

The first chapter treats of shop practices and methods of doing various kinds of work. The preservation of iron and steel is then briefly treated. Two chapters are devoted to notes on structural detail drawing and the detail design of cast bases and various types of connections for structural members of bridges and buildings. The next three chapters treat of general bridge, high building and mill building design.

The detail design of beams and girders, tension and compression members is given with many illustrations of good details to amplify the text. Chapters 12 to 16 inclusive discuss rivets and riveted connections in general; end connections of tension and compression members; splices and pins. Short chapters on loads and unit stresses; estimating weight; shear; camber; curvature on bridges; grade; provision for expansion and contraction; tractive stresses; notes on drawbridges; tanks; greenhouses and skylights; gears and inspection and tests of steel work contains much valuable information for the draftsman and designer. An important and valuable part of the book is the chapter of nearly 150 pages giving illustrations of general and detail designs of many kinds of steel structures taken from the leading technical journals. These are given as good examples of modern practice in steel design and should prove invaluable to the designer who does not have access to illustrations of such a wide range of designs.

A chapter on general engineering data gives short descriptions of large structures of various kinds which have been built, is interesting and shows what may be accomplished in structural steel. The book closes with a set of general specifications for structural steel work and a glossary of terms relating to structural engineering.

The specifications for railroad bridges differ materially in some cases from those of the American Ry. Eng. Assoc., mainly in the matter of allowable stresses and proportion of parts.

Some portions of Mr. Godfrey's specifications are very much more conservative than the A. R. E. A. specifications, while others are a great deal more radical.

The purpose of this work is to emphasize the principles of correct design as well as to point out a number of common errors in design. This the author has accomplished in a satisfactory manner, and although Mr. Godfrey's views on many points differ materially from those of many other prominent structural engineers, there is much in the book of value to the draftsman and designer.

The Missouri, Kansas & Texas is enlarging its shops at Denison, Tex.

The Minneapolis, St. Paul & Sault Ste. Marie is said to be considering the construction of an overhead viaduct to connect the Interstate bridge with its passenger station at Duluth, Minn.

The New York, Philadelphia & Norfolk and the Baltimore, Chesapeake & Atlantic will erect a $50,000 union depot at Salisbury, Md.

Concrete Arch Design.

THE PAPER by Mr. A. C. Janni, on Design of an Arch System by the Ellipse of Elasticity, a short abstract of which appears elsewhere in this issue, is one which should prove of unusual interest to the engineer and designer in this particular field.

A few years ago the design of a concrete arch was a matter at which most engineers balked and one which they avoided whenever possible. This was due to the fact that no rules of practice had been evolved, by test or otherwise, which were applicable to concrete arches, especially reinforced concrete arches. The early methods used were what can only be called "rules of thumb" derived from arches built of stone masonry. As a result, concrete in wasteful quantities was used and it soon became apparent that different methods of design would have to be evolved if the proper advantages of the properties of concrete, both plain and reinforced, were to be taken.

In the design of masonry arches with solid filled spandrels, the live load was a minor consideration, for by far the greater part of the load to be sustained was the dead load of the structure and the earth fill. No doubt it was for this reason that little or no refinement was used in the analysis of the arch ring for live load stresses.

The publication in 1895 of the results of a series of tests on full size concrete arches, made by the Austrian government, brought forth much new information on the subject of arch design. Soon after this the use of reinforced concrete arches was greatly increased, and better methods of design were gradually developed until now with the elastic theory and its various modifications, we have what appears to be the logical method of design for concrete arches. Mr. Thacher was the first in America to make use of the elastic theory for proportioning arches, and in 1894 built a highway bridge of 30 ft. span for heavy highway traffic at Rock Rapids, Iowa.

With the increasing use of concrete arches came the necessity of effecting economies in design in order to compete successfully with other types, and also in the concrete field. This led to the use of open or hollow spandrels, of the longitudinal arch, transverse open arch and the beam slab and column types, to support the roadway, thereby eliminating the dead weight of spandrel filling and allowing the use of arches of smaller cross-section. The search for further economy brought about the use of the ribbed arch and cellular abutments filled with earth to take the thrust of the arch.

The first ribbed arch of considerable span to be built in America was the Lake Park Bridge, Milwaukee, Wis., with a clear span of 118 ft. Other designs for ribbed arches were carried out soon after this in increasing numbers, until today all our large highway arches are of the ribbed type. The Larimer Ave. bridge at Pittsburgh, with a clear span of 300 ft. (described in Jan., 1913, issue *Railway Engineering*) represents the highest type of structure consistent with economy which has yet been built in America.

The use of ribbed arches for railway structures is just beginning, most railroad engineers, even the most progressive, having been satisfied to use open arch spandrels only in order to lessen dead weight, with the resulting economy. However, with the increasing lengths of spans being used for such structures, the use of ribbed arches will be necessary in order that the designs become more economical and that the loads on the foundations be not excessive. This is witnessed by the Tunkhannock Creek Viaduct, now being built by the D. L. & W. R. R., with ribbed arch spans of 180 ft. This bridge marks an epoch in the further decrease of dead loads to be sustained by railroad arch bridges, and also in he economic development of the concrete arch. The relation of the dead load to the live load to be sustained is more nearly balanced in this design than in any other structure for such loading heretofore built.

Since we have made such rapid strides toward economic design and construction, it is incumbent upon us to develop the method of the elastic theory in such a manner as to shorten and facilitate as much as possible the computations and graphical analysis of design in order that further economy may be effected in the cost of design.

The method of analysis developed by Mr. Janni materially lessens the labor, in fact to about one-half of that necessary with most methods, since it is purely graphical and eliminates the cut-and-try methods which make arch design a tedious job. This is due to the fact that the theory of the ellipse of elasticity holds good without respect to form of arch or variation of cross-section of ring and is independent of a hypothesis of loading.

A thorough study of this paper should be made by all engineers interested in arch design for there is no doubt that this method is a step toward further economy in the cost of engineering design of arches.

DESIGN OF A CONCRETE ARCH.

A valuable paper on "The Design of an Arch System by the Method of the Ellipse of Elasticity," by A. C. Janni, C. E., was published in the May issue of the Journal of the Western Society of Engineers. A lengthy abstract of this paper cannot be given here, and the reader is referred to the original paper for the detailed treatment, which is one of exceptional value. The fundamental differences of this method from the usual methods of the elastic theory are given below.

Mr. Janni states that the usual methods used in designing an elastic arch render it impossible to study the arch separately from assumptions as to loadings, which means that besides the necessity of considering the shape of the arch, the amount and distribution of load coming upon it must be considered. This is extremely laborious, since any change in the loading assumed makes a repetition of the entire computation of stresses necessary.

The method of the ellipse of elasticity is a purely graphical one, and holds irrespective of the geometrical form of the axis

of the arch and also irrespective of the law of variation of cross-section of the latter and the assumptions of loading. The paper gives the application of this method to the design of the Kingshighway Viaduct in St. Louis, the underlying theorems being given in an appendix to the paper as read.

Mr. Janni states in conclusion that various combinations of analytical and graphical methods have been devised depending upon certain arbitrary assumptions, which to some extent facilitate the application of the elastic theory to arch design. The purely graphical method has great advantages over analytical or combined analytical and graphical methods.

By the method of the ellipse of elasticity developed by Mr. Jannie, it is possible to draw the influence lines for moments with regard to any section. These influence lines show at once, with respect to that section, the most prejudicial hypothesis of loading, and this independent of any assumptions. In other words, the influence lines for moments, for vertical reactions and horizontal thrusts, are constructed absolutely independent of any hypothesis of loading, and are dependent solely upon the geometrical shape of the arch considered. They are characteristics peculiar to the arch alone and serve for the complete calculation of the stresses in any section caused by loading according to any hypothesis.

The essential advantage of the ellipse of elasticity theory is that all the properties of an elastic structure required for its complete investigation, for any assumed system of loading, can be collected under one concept independent of the forces which may act thereon. This eliminates much cut-and-try labor, and permits the development of a very flexible working method of design.

CURRENT PRICES—CONCRETE MATERIALS.

For the benefit of our readers interested in the concrete field and in line with our aim to make the concrete department one of the best in the field, we have decided to devote a small portion of our space each month to a list of current prices on cement, steel and other materials entering into concrete structures. Such information should prove indispensable to the engineer whose duties necessitate the frequent preparing of numerous estimates on concrete structures. To the engineer or designer who has to prepare estimates on such work only occasionally, this new departure may be of still greater benefit. In order to make this information as complete and of such character as to be of use to our readers in various parts of the country we ask the co-operation of our readers who may be in a position to furnish data regarding prices in their respective localities. We have little doubt but, that with the proper co-operation of all concerned this feature can be made a permanent and valuable one.

PRICES.

Portland cement—

New York—$1.58 delivered within lighterage limits, or 95c to 98c per bbl. in bulk at the mill.

Boston—$1.72 less 40c for bags returned.

Chicago—$1.20 per bbl., some large orders at $1.10.

Crushed stone—

New York—90c to $1 per cu. yd. for full cargo lots of 500 cu. yds. delivered at the docks.

Chicago—Car load lots $1.15 per cu. yd. f.o.b. Chicago.

Sand—

Chicago—Carload lots, $1.15 per cu. yd. f.o.b. Chicago.

Gravel—

Chicago—Car load lots, $1.15 per cu. yd. f.o.b. Chicago.

Reinforcing bars—

Pittsburgh base quotations on mill shipments f.o.b. Pittsburgh, are 1.45 cts. on plain bars and 1.50 cts. on deformed bars, with the prevailing extras for bars under ¾-inch or base. Demand not very active, but stocks are no more than normal. Shipments from Pittsburgh stock at 1.95 cts. base; New York stock 2.25 cts base; Chicago stock 2.05 cts. base in large lots.

PORTLAND CEMENT STATISTICS FOR 1912.

From report of C. F. Burchard of the U. S. Geological Survey.

The total quantity of portland, natural and puzzolan cements produced in the United States during 1912 was 83,351,191 bbl., valued at $67,461,513. Of this amount a total of 82,438,096 bbl. of portland cement with a value of $67,016,928, was produced, as compared with 78,528,637 bbl., valued at $66,248,817 in 1911. This represents an increase of 3,909,459 bbl. or nearly 4.98% in quantity, representing an increase in value of $768,111 or 1.13%.

The mill shipments in 1912 were for a total of 85,012,556 bbl., valued at $69,109,800, compared with 75,547,829 bbl., valued at $63,762,638, shipped in 1911. This represents an increase of 9,464,727 bbl. or 12.52% and an increase in value of $5,347,162 or 8.38%. The average price per bbl. in 1912 was a little less than 81.3 cents as compared with 84.4 cents in 1911. This represents the value of cement in bulk at the mills, including labor and cost of packing, but not the value of sacks or barrels. The average price per bbl. for the country is about 13.9 cents higher than the average price in the Lehigh district, where it was sold at the cheapest rate, and is near the average price in the Iowa-Missouri district, but it falls 54.5 cents below the average Pacific coast price which is the highest figure for the year.

The apparent stock on hand at the end of 1912, according to reports and revised estimates, amounted to 7,811,329 bbl., compared with 10,385,789 bbl. on hand at the close of 1911.

The imports of hydraulic cement in 1912 were approximately 68,503 bbl., valued at $93,558 or about $1.37 a barrel. This is a decided decrease in quantity compared with 1911 when 164,670 bbl., valued at $242,722 or $1.47 a barrel, was imported. The exports, mostly portland cement, amounted to 4,215,532 bbl., valued at $6,160,341 or about $1.46 a barrel. This is about 5% more than the exports of 1911, which were 3,135,409 bbl., with a total value of $4,632,215 or $1.477 a barrel.

THEORY AND DESIGN OF REINFORCED CONCRETE.

Editor Railway Engineering:

I was much interested in your editorial in the June issue on page 306, on Theory and Design of Reinforced Concrete. It is amazing what illogical and dangerous things are put forth under the guise of engineering science in this field by nearly all of the writers and many of the most prominent specialists in reinforced concrete.

I hope you will keep it up until shear rods, stirrups, rodded columns, and some other errors go into oblivion, where they belong. (Signed) Edward Godfrey.

The Denver & Rio Grande, it is reported, has appropriated $100,000 for a new freight depot at Ogden, Utah. It is also reported that this road has ordered steel for several bridges aggregating about 1,000 tons from the American Bridge Co.

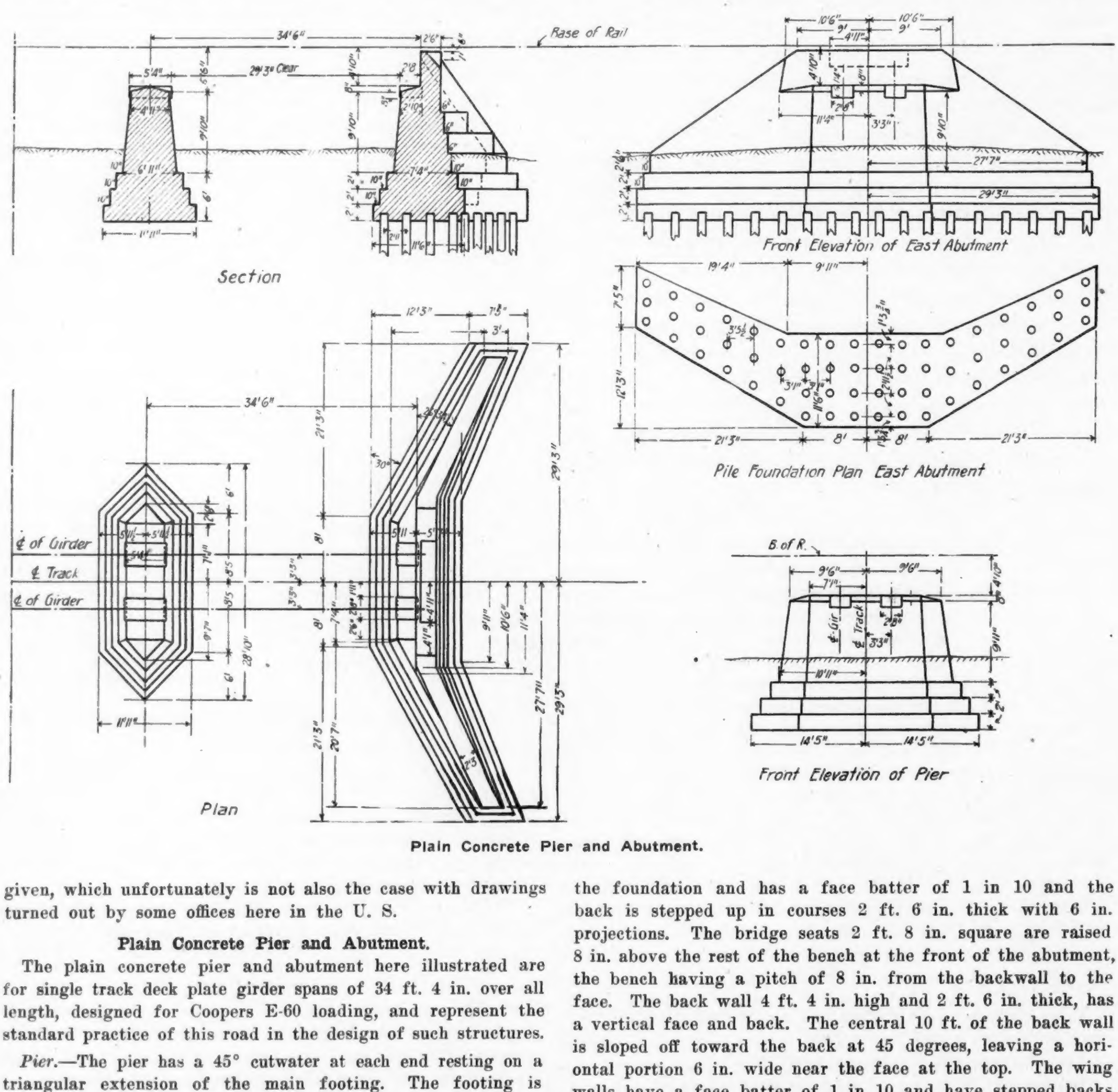
The Gulf, Colorado & Santa Fe will open bids on June 18 for the construction of a planing mill, dry kiln and 3 concrete transfer pits, to be built at Cleburne, Tex., to cost about $65,000.

The Denver & Rio Grande has awarded a contract to the Roberts & Schaefer Co. to build two large, counterbalanced Holmen type locomotive coaling stations. One will be built at Salida, Colo. and the other at Minturn Colo. The contract price is approximately $22,500.

CONCRETE PRACTICE—NATIONAL RAILWAYS OF MEXICO.

By A. M. Wolf, C. E.

The publication of descriptions and illustrations of the standard concrete practice of the National Railways of Mexico will no doubt be of interest to the English speaking engineer. The illustrations herewith given were taken from blueprints furnished by the National Rys., the notes thereon appearing in Spanish having been translated and the dimensions given in meters converted to feet and inches in order that they may be more useful to our readers. One thing which impresses the writer was the painful neatness of the drawings and lettering as originally executed and the completeness of the dimensions given, which unfortunately is not also the case with drawings turned out by some offices here in the U. S.



Plain Concrete Pier and Abutment.

Plain Concrete Pier and Abutment.

The plain concrete pier and abutment here illustrated are for single track deck plate girder spans of 34 ft. 4 in. over all length, designed for Coopers E-60 loading, and represent the standard practice of this road in the design of such structures.

Pier.—The pier has a 45° cutwater at each end resting on a triangular extension of the main footing. The footing is 11 ft. 11 in. wide and 28 ft. 10 in. long over all, built in three courses each 2 ft. thick with 10 in. projections, the width of the pier at the top of footing being 6 ft. 11 in. The ratio of base to height is about 0.45. The neatwork of the pier has a batter of 1 in 10 making the top width of pier 4 ft. 11 in. The top of pier between bridge seats for girders, which are 2 ft. 8 in. wide, is beveled off 8 inches from the transverse center line of pier to the edges. The bridge seats with centers 3 ft. 3 in. from center line of track project 2½ inches beyond the remainder of pier top. No information as to the mixture of concrete used is available.

Abutment.—The plain concrete wing abutment has a foundation 6 ft. thick in three courses with 10 in. projections beyond the course above. The entire abutment rests on a foundation composed of 60 piles, spaced in four rows at 2 ft. 11½ in. by 3 ft. 1 in. centers under the abutment proper and in three rows under the wings at about the same spacing. The pile cutoff is 1 ft. above the bottom of the footing. No piles are placed nearer to edge of foundation than about 1 ft. 4 in. The footing is 11 ft. 6 in. wide at the main portion and 7 ft. 5 in. wide parallel to center line of track at the ends of wings. The abutment is 7 ft. 4 in. thick at the top of the foundation and has a face batter of 1 in 10 and the back is stepped up in courses 2 ft. 6 in. thick with 6 in. projections. The bridge seats 2 ft. 8 in. square are raised 8 in. above the rest of the bench at the front of the abutment, the bench having a pitch of 8 in. from the backwall to the face. The back wall 4 ft. 4 in. high and 2 ft. 6 in. thick, has a vertical face and back. The central 10 ft. of the back wall is sloped off toward the back at 45 degrees, leaving a horiontal portion 6 in. wide near the face at the top. The wing walls have a face batter of 1 in 10 and have stepped backs same as the main portion of the abutment. The top of the wings is 2 ft. 3 in. wide and they have a 1½ to 1 top slope down to a point about 6 in. above ground level. The wing walls flare back at an angle of 30° with the face of the abutment.

The practice of forming level bridge seats on piers and abutments for the girders and beveling the rest of the top appears to be a good detail and one which could be used

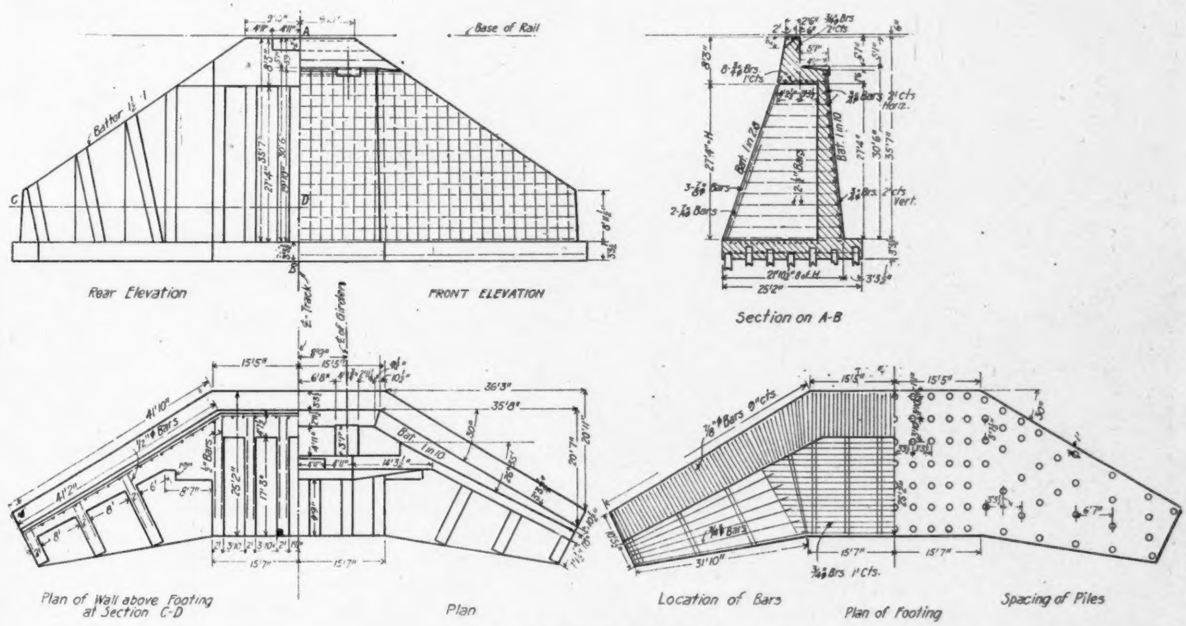
to advantage in railroad bridge design here in the states. The footings used are in general made heavier and more massive than is the practice of our U. S. railroads. The wing walls are sloped down to a point very much nearer the ground than is the general practice of our leading roads.

Reinforced Concrete Abutment.

The reinforced concrete abutment shown has a total height of 35 ft. 7 in. from top of footing to top of back wall. The abutment was designed for Cooper's E-60 loading. The width of the base at the top of the footing is 0.8 of the height from footing to bottom of bridge seat or 21 ft. 10½ in. The footing has a projection of 1 meter or about 3 ft. 3½ in. beyond the face of the abutment. The footing for main abutment and wings is 3 ft. 3½ thick with piles spaced 3 ft. 3½ in. by 3 ft. 10 in. in centers under the main portion of abutment. The piles under the wing wall footings are spaced as shown on plans, which arrangement is quite unusual, the extra pressure at the toe at connection with main abutment wall being taken care of by bunching the piles at that point. The abutment footing is reinforced transverse to center line with ¾ in. dia. bars 1 ft. centers near top and bottom, between back of face wall and heel of abutment, the bottom bars being placed about 1 ft. above the bottom of footing. The toe is reinforced for cantilever action by ⅞ in. dia. bars about 7 ft. long, 9 in. centers perpendicular to face of abutment and wings, placed near the bottom of the footing. At points where buttresses rest on the footings two of these cantilever bars extend the full width of the footing. The longitudinal bars in the wing footings are ¾ in. dia. spaced about 1 ft. centers at the ends of wings fanning out to about 2 ft. spacing at connection with main portion of the footing.

The face wall of the abutment is 1 ft. 8 in. thick at the bridge seat with a face batter of 1 in 10 and a vertical back making the thickness at the footing 4 ft. 7½ in. This wall (as well as the wing walls) is designed as a buttressed wall with six buttresses 2 ft. thick and about 3 ft. 10 in. clear between buttresses extending to the heel of the footing. The wings have three buttresses of the same thickness spaced 10 ft. centers, one buttress being placed at the end of the wing. The breast wall of the abutment and the wing walls are reinforced near the outer face with ¾ in. dia. bars 2 ft. centers horizontally and vertically. The vertical bars do not extend into the footings. The buttresses for the main portion of the abutment, i.e., those under the bridge seat are 27 ft. 4 in. high and are reinforced with ½ in. dia. stirrup bars spaced about 2 ft. centers horizontally, anchoring the buttresses to the face wall. These bars extend to the back of the buttresses. The backs of the buttresses, which have a batter of 1 in 2.8 are reinforced by, and anchored to the footing by three ⅞ in. dia. bars extending from bottom of footing into the bridge seat and two ⅞ in. dia. bars which extend only a little over one-half the height of the buttresses. The wing wall buttresses are reinforced in a similar manner. The wing walls have a 30° flare at the base, and are connected to the end buttresses of breast wall with a large triangular block of concrete in order to lessen the danger of cracks between abutment wall and wings.

The bridge seat is 3 ft. 2 in. thick at pedestals for girders, between and at the sides of the pedestals the bridge seat has a slope of 8 inches from face of back wall to face of abutment, making the thickness at that point 2 ft. 6 in. The bridge seat is reinforced with eight ¾ in. dia. bars spaced 1 ft. centers spanning between buttresses. The girder pedestals 4 ft. 1¾ in. wide by 5 ft. 1 in. long project 2 inches beyond abutment face.



Reinforced Concrete Abutment.

The back wall with vertical face and battered back is reinforced with ¾ in. dia. bars 2 ft. centers horizontally. The top width of the back wall is 2 ft. 6 in., the top for about 5 ft. each side of the center line of abutment being beveled off at 45 degrees from a point 6 in. back of the face. The top of back wall is 6 in. below base of rail and is reinforced with three ¾ in. dia. bars.

In general the concrete sections used in this abutment are heavier than is the usual U. S. practice, with a consequent reduction in the amount of reinforcement. The method of anchoring buttress bars, however, is not as positive in character as that used by most of our lines. A notable feature is the comparatively wide base, i.e. 25 ft. 2 in. for a total height of abutment of about 32 ft. (Compare with reinforced concrete abutment illustrated and described on pages 136 and 137, March 1913, issue Ry. Eng.—*Editor.*)

We are indebted to Mr. James M. Reid, chief engineer, for plans and data used in preparing this article.

The Signal Department

ELECTRIC INTERLOCKING AT ALIQUIPPA, PA.

By B. W. Meisel.

Recently the Pittsburg & Lake Erie R. R. installed at Aliquippa, Pa., an all electric interlocking plant, at the entrance of a large yard between four main lines, which consist of two freight and two passenger tracks, one of each on each side of the yard.

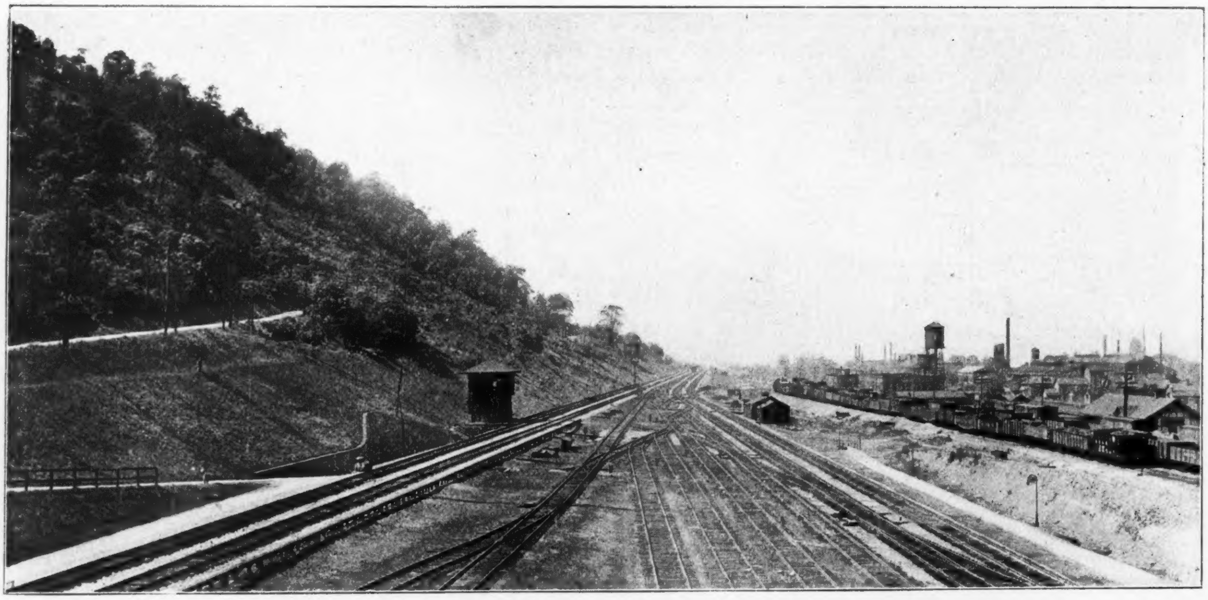
The machine controlling the functions of this plant is a model 2 G. R. S. Co.'s unit lever type, consisting of 75 working levers in an 88-lever frame. There are 12 levers for 12 high signals, 22 levers for 22 dwarf signals, 37 levers for 37 switches and derails, and 4 levers for 4 train order signals, making a total of 75 working levers. The remaining spaces in the machine are spare.

The track and signal plan shows the location of all functions controlled by the interlocker, and the automatic signals at the ends of the plant. Note that there are only two derails in the entire interlocking. These are of the Hayes type and are located on the long freight transfer tracks leading from the outside main lines, which are passenger tracks. The derails are used to protect these tracks, there being some possibility of long freight drags overrunning the signals.

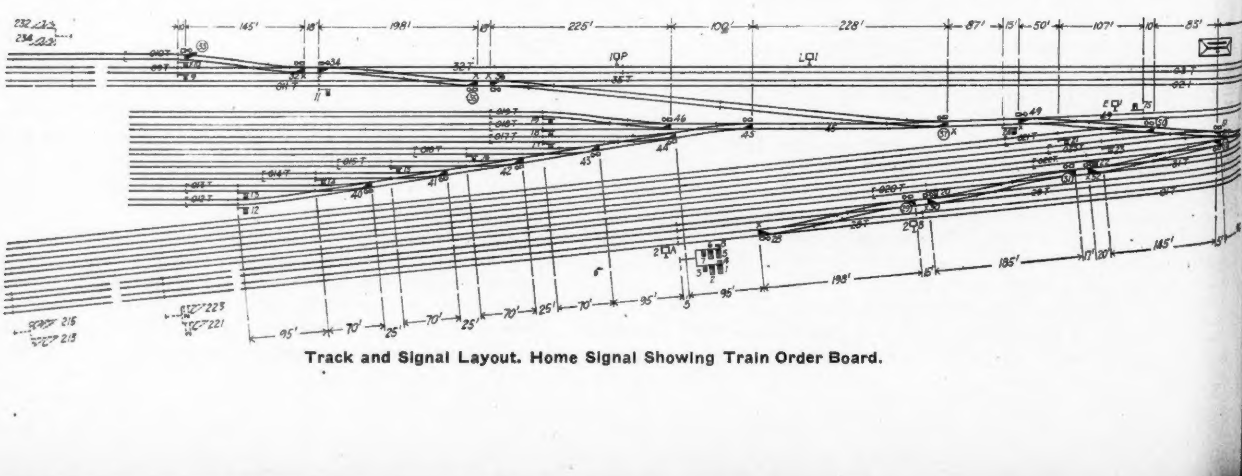
High signals, both interlocking and automatic, are located on bracket posts. Automatic signals are two position lower quadrant, while the interlocked signals operate in the upper quadrant. The high signals of the plant are 110 volt, model 2A, 3 position semiautomatic stick signals. The call-on signals are of the same model but are non-automatic and only operate to 45 degrees.

Dwarf signals are G. R. S., model 30,710, operating to 45 degrees. The night indications are: Clear, green; caution, yellow; stop, red. Signal lamps are oil, long time burners.

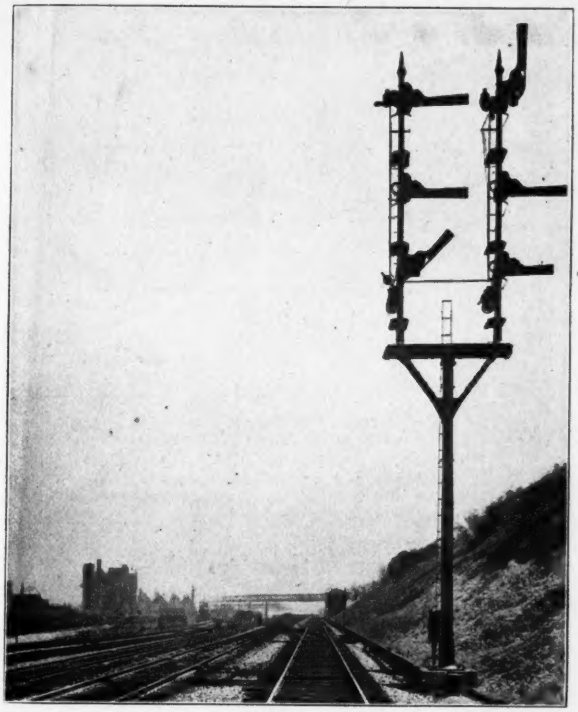
All switches and derails are operated by G. R. S., model 4, switch machines. The current to operate all high voltage functions is taken from 56 cells of storage battery. The track circuits are fed from 3 sets of storage, 2 cells each in duplicate. A low voltage battery of 5 cells of storage in duplicate furnishes current to low voltage circuits. The charging apparatus consists of a single phase motor generator set (110 volt, 60 cycle motor, direct connected to generator). The switchboard wiring diagram shows the various batteries on charged and discharge, the motor generator set, and switches, with all connections. The storage battery and power equipment is located on the ground floor of the tower.



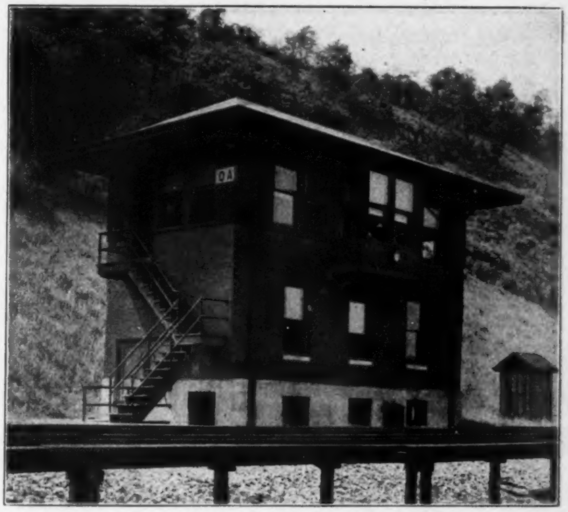
General View, Aliquippa Interlocking.



Track and Signal Layout. Home Signal Showing Train Order Board.



Home Signal Showing Train Order Board.



Aliquippa Interlocking Tower.

A number of circuit plans are shown here to illustrate the present method of drawing such plans for a large plant of this kind. These are used in construction and for final records. The old method of drawing up circuit plans for signal installations usually resulted in such a mixed up mess of lines, representing wires and apparatus, that by the time any one except the man who designed them, was able to trace and read each circuit in an understanding way, the installation was in service.

The present method of drawing circuits eliminates the complicated layouts and gives a clean, clear cut circuit. These circuits are termed "written circuits," and involve a set of plans which include: A location plan of all apparatus, a typical plan of special circuits showing what is proposed to accomplish in route locking, etc., drawn up in the usual form or written form, typical plans for signal circuits, switch circuits, etc., and special circuits.

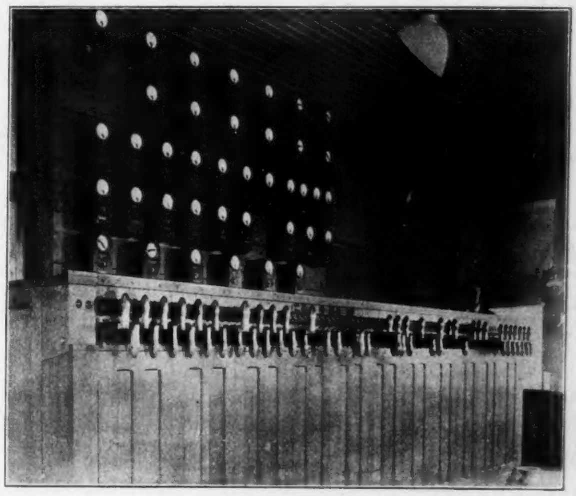
To successfully accomplish this it is necessary to use a nomenclature for naming the apparatus, and adopt symbols for writing the circuits. Hence the following key to this system of circuits, which must necessarily be somewhat arbitrary; and yet it will be noted that in many ways it is highly suggestive.

Symbols and Nomenclature for Written Circuits.

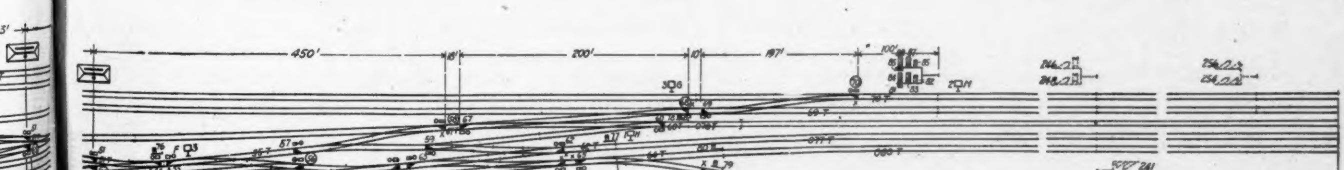
Nomenclature of Operated Units.

A—Approach Relay or Indicator—With number as prefix, indicating number of principal signal up to which the approach section controlling same leads, as 10A.

B—Positive Battery Wire—Used alone where only one battery voltage is in use. When used with H as a suffix (BH) in-



Interior of Tower.



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Nomenclature of Circuits.

On Operated Unit (Signal, Relay Indicator etc.) is represented by a rectangle with the number and letter of the relay, signal, etc. inside, thus -

10 H   10 F   10

The 45° mechanism of a 3-position signal is indicated thus -

$\frac{10}{45}$

and the 90° thus-

$\frac{10}{90}$

Circuits Controllers Operated by Levers

N B C D R Symbol

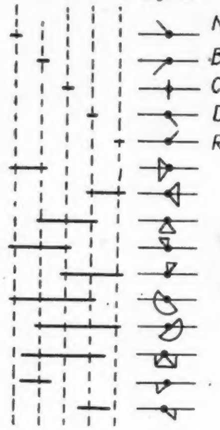
N - Full normal position of lever.

B - Normal indication position

C - Intermediate position.

D - Reverse indication position.

R - Full reverse position.



Heavy horizontal line indicate portion of cycle of lever through which circuit is closed

Circuit Controllers Operated by Switch Points

	Sw No
Closed when switch is normal.	10
Closed when switch is reversed	(10)
Closed when switch is normal and locked in position	|10|
Closed when switch is reversed and locked in position	|(10)|

Circuit Controllers Operated by Signals

	Signal No
Closed at 0° only	$\frac{10}{0}$
Closed at 45° only	$\frac{10}{45}$
Closed at 90° only.	$\frac{10}{90}$
Closed at 60° only	$\frac{10}{60}$
Closed between 0° and 45°	$\frac{10}{0\text{-}45}$
Closed between 45° and 90°	$\frac{10}{45\text{-}90}$
Etc.	

Relay and Indicator Contacts

	Relay No.
Neutral front contact	10T
Neutral back contact	10T
Normal polarized contact	|10T|
Reverse polarized contact	|10T|
Intermediate contact on 3-position relay Closed when relay is de-energized.	→ 10T ←

Time Release Contact

Normally Closed	10TR
Normally Open	10TR

Latch Contact

Normally closed	10LC
Normally Open	10LC

Push Button or Strap Key

Normally closed	PB
Normally open	PB

Knife Switch

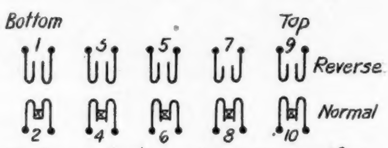
Normally closed	KS
Normally open	KS

Terminal 10J Meaning terminal in junction box number ten or on terminal board number ten.

Note Small numbers written as exponents to the right and above relay numbers, lever numbers, etc., indicate Contact numbers.

Relay or indication contacts are numbered from left to right to one facing the relay.

Lever contact numbering- Model 2 Machine.



Other controller contacts numbered as specified

dicates 110 volt battery. When used with L as a suffix (BL) indicates low voltage battery. When more than one low voltage battery is used with different voltage, use number indicating voltage as further suffix, as BL-10, indicating 10 volt battery.

C—Common Wire—Used alone when only one common is in use. When used with H as a suffix (CH) indicates 110 volt common. When used with L as a suffix (CL) indicates low voltage common. When more than one high voltage or low voltage common is used, use numbers as further suffixes (CH-1, CH-2, CL-1, etc.).

D—Relay or Indicator Controlling the 90° Position or Distant Function of a Signal—With prefix indicating the number of principal signal which it controls, as 10D, indicating relay or indicator controlling the 90° position of signal number ten, or signal number ten if it is a distant signal in two-position signaling.

E—Special Relay or Indicator (Other than T, D, H, K, or F relays and indicators)—With number as prefix, indicating number of principal unit entering into its control, or indicating principal unit which it controls.

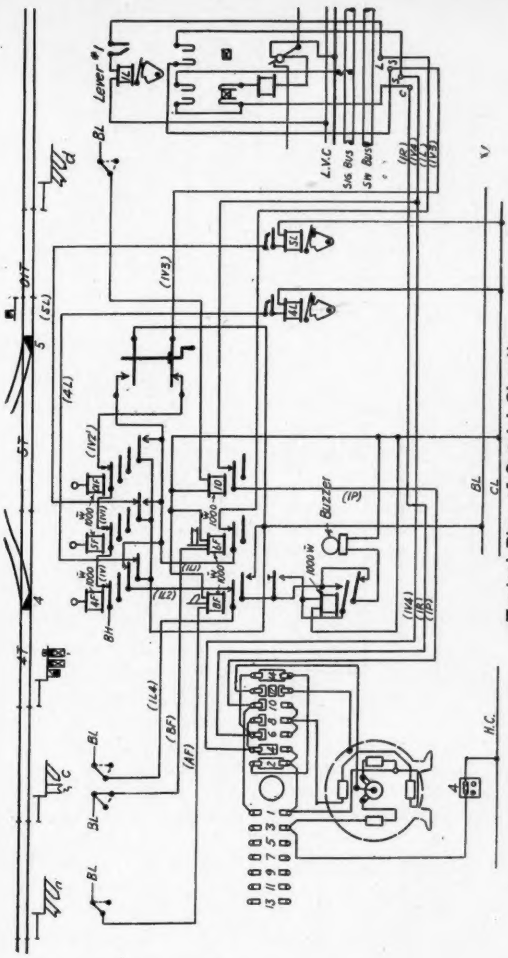
F—Relay or Indicator Repeating a Track Relay or Signal—With number as a prefix indicating number of relay or signal which it repeats, as 10F.

FP—Floor Push—

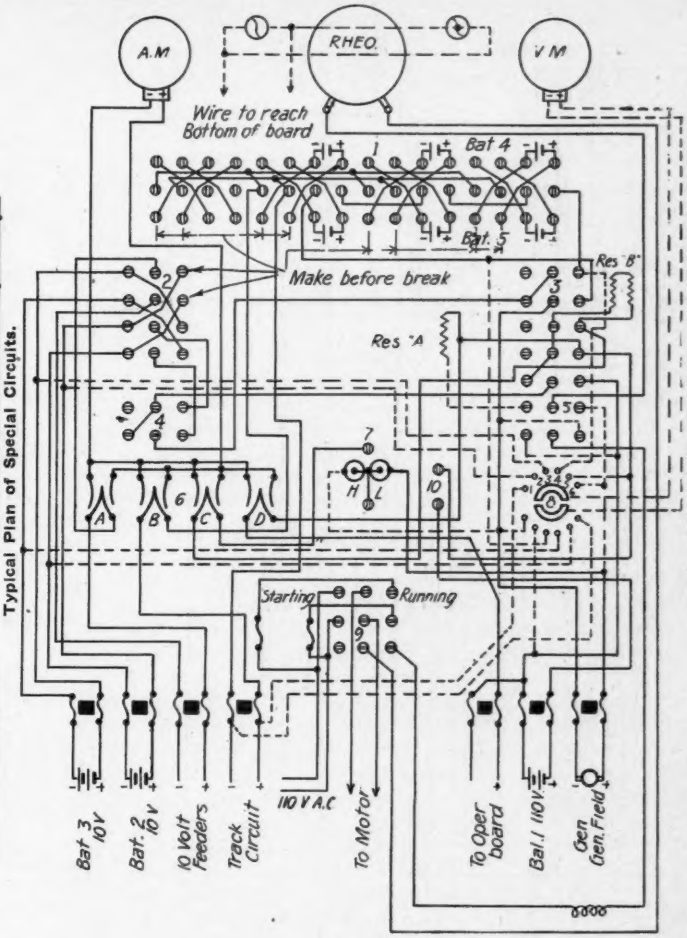
G—Switch Indicator—With number of signal governing through block in which switch is located as prefix, as 10G.

H—Relay or Indicator Controlling 45° Position or Home Function of a Signal—With prefix indicating the number of principal signal which it controls, as 10H, indicating relay or indicator controlling the 45° position of signal number ten, or signal number ten if it is a home signal in two-position signaling.

J—Junction Box or Terminal Board—With arbitrary number as prefix, as 10J.



Typical Plan of Special Circuits.



Wiring Plan for Switch Board.

K—Lock Relay—Used in connection with route or detector locking for interrupting the current supply to switch and derail machines, etc., with number as a prefix, indicating track section affected by it, as 10K.

KS—Knife Switch.

L—Lever Lock—With prefix indicating number of lever which it locks, as 10L, meaning lock on lower ten.

LA—Lightning Arrester—

LC—Latch Contact—With prefix indicating number of lever, as 10LC.

M—Man Hole—With arbitrary number as prefix, as 10M.

PB—Push Button or Strap Key—

S—Stick Relay—Used in connection with route locking, with number as prefix, as 10S, meaning stick relay locking route of signal 10, or locking operated units in track section of 10T, if separate stick relays are used for each track section.

T—Track Circuit—With number as prefix indicating number of track circuit, as 10T, which is also the name of the track relay for track circuit 10T.

NOTE: The number for the track circuit is taken from the following in the order given:

M. P. Frog or
Switch or
Derail or
Arbitrary numbers 01, 02, 03, etc.

TL—Traffic Lock—With prefix indicating number of lever which it controls, as 10TL.

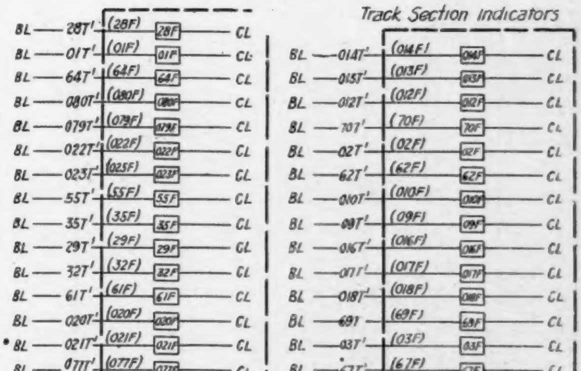
TR—Time Release—With number as prefix indicating principal unit which it releases, as 10TR.

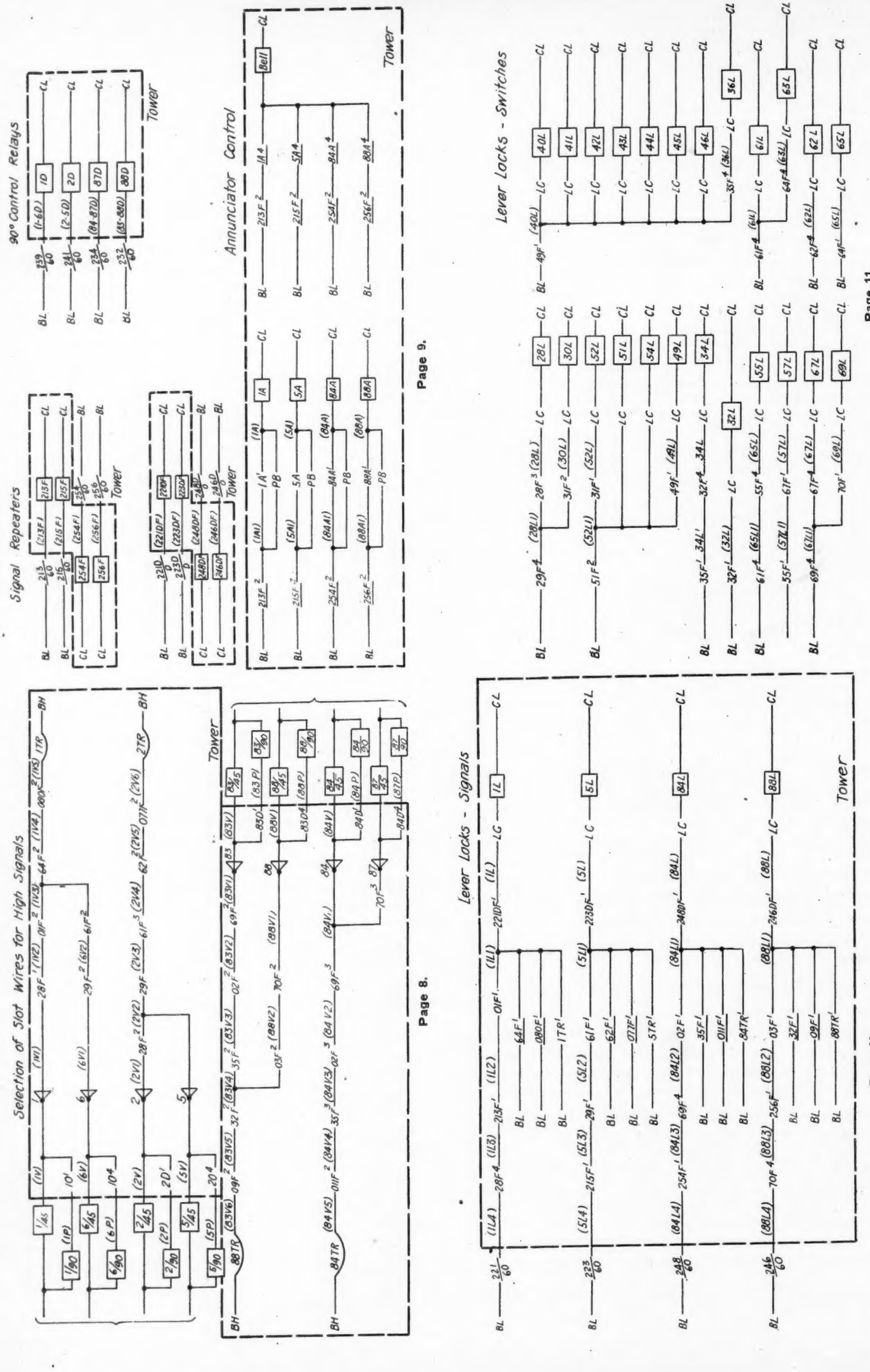
V—Electric Slot—With number of signal as prefix, as 10V.

NOTE: Names of wires are shown on plans in brackets, thus: (10D).

Number of cable containing a wire may be written above and at right angles to the wire. Thus: 10

Track Section Indicators





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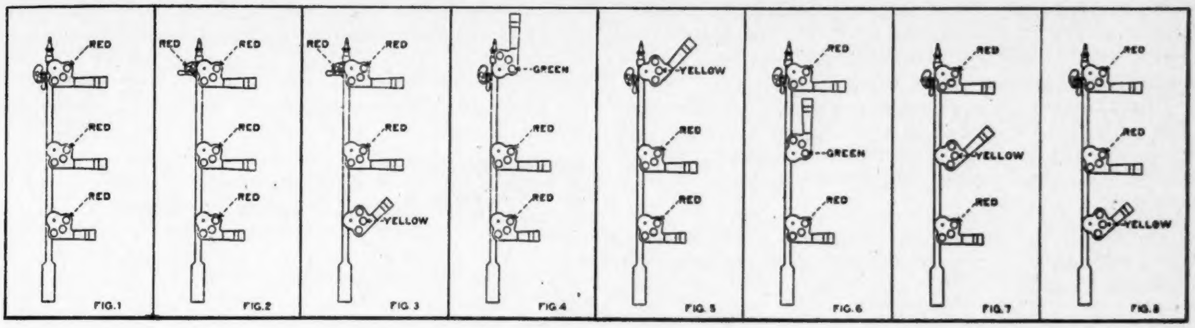
Special Circuits, Aliquippa Interlocking.



Signal Indications.

LL—Lighting Wire—

N—Normal Control Wire—With number of operated unit which it controls as prefix, as 10N.

P—Ninety Degree Control Wire—With number of signal as prefix, as 10P.

R—Reverse Control Wire—With a number of operated unit which it controls as prefix, as 10R. If ten is a 3-position signal, 10R is the name of the 45° control wire.

V—Slot Wire—With number of signal and prefix, as 10V.

X—Wire going to positive battery through a circuit controller on a signal closed in 0° position only, with the number of the signal as a prefix, as 10X.

Y—Wire going to positive battery through a circuit controller on a signal closed from 0° to 45° only, with the number of the signal as a prefix, as 10Y.

Z—Wire going to positive battery through a circuit controller on a signal closed in clear position if the signal is a 2-position signal, or closed from 45° to 90° if the signal is a 3-position signal, with the number of the signal as a prefix, as 10Z.

Wires not covered by the above are named as follows:

A wire leading from the operating coil of a unit toward battery positive takes the name of this unit, as 10H, meaning the wire from the coil of home signal relay for signal ten leading to positive. After passing through a circuit controller, it takes the number "1" as a suffix, as 10H1. This suffix number increases by one as the wire successively breaks through additional controllers.

The wire leading from the operating coil to battery negative takes the name of the unit with the letter "C" as a prefix, as 01CR, and after breaking through successive controllers is written C10H1, C10H2, etc.

The above method supplied directly to simple circuits having no branches. Thus:

C-16F (C 10 H1) 18F (C 10 H1) [10H] (10 H) 17F 10 H 1 14 F-B

In cases of branch wiring this method is applied directly to the principal circuits—circuit for superior route. The first branch from this circuit takes the suffixes 21, 22, etc., instead of 1, 2, etc. The second branch 41, 42, etc., thus continuing allowing twenty numbers for each branch.

How to Read Circuits.

Example: Circuits, Page 8: Selection of slot circuit for high signal No. 1. Starting at the mechanism for the 45° position of signal No. 1 read across the page. The wire entering the tower is tagged (1V); the V stands for electric slot (see nomenclature). The circuit breaks through circuit breaker on No. 1 lever which is closed from reverse indication position to full reverse position. Tag on wire (1V1). The suffix—1—indicates the first break in wire. Circuit breaks through $28F^1$, which is the first point of repeater for track circuit, or relay, 28T (see track plan); tag ($1V^2$) breaks through $O1F^2$ (repeater for O1T); tag ($1V^3$) breaks through $64F^2$ (repeater for 64T); tag ($1V^4$) breaks through $080F^2$ (repeater 080T); tag ($1V^5$) breaks through 1TR (time release) to battery BH (110 volt). For common selection signal No. 1 see page 12 (circuits). Read from Signal 1 across page, tag on wire (1C); circuit breaks, through 28 normal (switch 28), tag (1C1), taps to wire tagged ($6C^2$), breaks through 65 normal (switch 65) to high voltage common.

Train Order Board.

One of the interesting features at interlocking plants of the Pittsburg & Lake Erie R. R., is the train order indicator mounted on home signal masts, shown in the illustrations herewith as used at Aliquippa. The signal indications shown here are as follows:

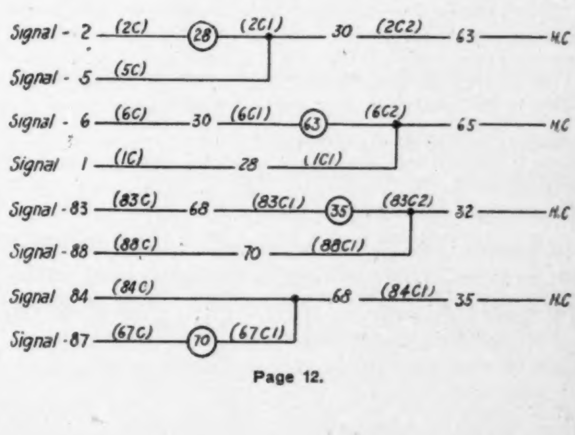
Fig. 1 shows the home signals in the stop position, for interlocking reasons. It indicates "stop." Fig. 2 shows the home signals in the stop position and the train order signal is also in stop position. If the towerman can allow the engine and train to pull up to the tower he will do so by placing the "calling on" arm (which is the lower short blade) in the caution position, see Fig. 3. This, however, will be done only after the engineman has given whistle signal that he has received and accepted the display of the train order signal.

Fig. 4 shows signals indicating "proceed" at schedule speed on the high speed track. This indication conveys the information that (a) the plant is lined up and locked, (b) the automatic block is clear, (c) the next automatic block signal ahead is clear, and (d) there are no train orders.

Fig. 5. This is the same as Fig. 4, with the one exception (a) the next automatic block signal ahead is in the stop position; be prepared to stop at it.

Fig. 6 indicates proceed at medium speed to a diverging route with the direction of traffic. This indication conveys the information that (a) the plant is lined up for a diverging route with traffic, (b) the automatic block to be entered is clear, (c) the next automatic block signal ahead is clear, and (d) there are no train orders.

Fig. 7 indicates the same as Fig. 6, with the one exception that (c) the next automatic block signal ahead on the track to be entered is in the stop position; be prepared to stop at it.



Page 12.

Fig. 8 indicates a slow speed movement and simply gives the information that the interlocking plant is lined up for some route. The train must protect itself on the track to be entered until it reaches the next signal, if any, ahead.

Dwarf signals at these plants are operated in the upper right hand quadrant. The blade is inclined upward at an angle of 45 degrees, with a yellow light at night for proceed, and the blade in a horizontal position with a purple light at night indicates stop.

This plant was built under the supervision of J. A. Atwood, chief engineer, and I. S. Raymer, assistant signal engineer of the Pittsburgh & Lake Erie Railroad. We are indebted to the latter for information and illustrations used herein.

MEETING OF WESTERN SIGNAL ENGINEERS.

E. J. Stradling, Secretary of the Western Signal Engineers, has issued a call for a meeting, July 10, at the Karpen Bldg., Chicago. The meeting will be convened at 10:00 a. m. From 12:15 to 2:00 p. m. the meeting will be adjourned for lunch and to visit the Railway Supply Exhibit. Discussion of the subjects will be again taken up at 2:00 p. m. and final adjournment will be taken at 5:00 p. m. The following subjects are to be discussed: (1) Distribution of Units for Interlocking Plants; (2) Rules for Installation, Operation and Maintenance of Interlocking Plants (Revised by the railways of Illinois, Indiana and Wisconsin).

Personals

O. O. Otto has been appointed supervisor of signals of the Chicago Great Western R. R. at Clarion, Ia., succeeding R. R. Rockwell, resigned, effective June 7.

E. C. Hitchcock, formerly signal inspector, has been appointed signal supervisor of the New York, New Haven & Hartford R. R., at Waterbury, Conn. John Pilkington, formerly signal inspector, has been appointed signal supervisor at Taunton, Mass. C. O. Warner, formerly signal inspector, has been appointed signal supervisor at Hartford, Conn.

W. M. O'Laughlin has been appointed supervisor of signals of the Northern Pacific Ry. at St. Paul, Minn., succeeding W. Kearton.

The Maintenance of Way Department

Slides and Sink Holes

ON ANOTHER PAGE of this issue there appears an article on slides, which was submitted as a result of the recent requests for articles on "washouts." This article contains some valuable information, and we would like to obtain others of a similar nature.

Undoubtedly a great many roadmasters and foremen have had considerable difficulty and experience with either slides, or sink holes. And the experiences of many of our readers along this subject would probably furnish valuable information. It is well to call attention to the fact that widest latitude is invited, both in covering this subject or any other suggested in this department, and also in submitting articles on any live subject of interest to maintenance men. The following outline is suggested for descriptions of "Slides" or "Sink Holes":

Minute description of conditions (with sketch or photograph if possible).

Time of first appearance of trouble—during construction or later.

Cause or causes which first brought trouble to surface (if occurring after construction).

Description of difficulties experienced, condition of materials under roadbed, as far as your knowledge goes.

Methods used to eliminate trouble,.

Method which was effective in curing the trouble.

Reasons why the method was effective.

All articles submitted and published on this subject will be paid for at space rates. Photographs or diagrams accompanying articles will also be paid for. Address letters to Editor Railway Engineering and Maintenance of Way, 431 South Dearborn street, Chicago, Ill.

PIECE WORK.

J. J. Hess.

I have never used piece work, but have observed where contracts were let for casting dirt or using wheelbarrows in building grade for railways, where men were paid on a yardage basis, and it was very satisfactory to all concerned.

I have always endeavored to organize gangs so each man would have a certain amount to do to keep up his end of the work; for instance, in cutting weeds I have each man take a rail or two, as the case may be. The same thing applies in tamping ties, only that one-half rail lengths are usually assigned every two men, on each side of track. This is done in order to close work up quickly to allow trains to pass with as little delay as possible. In spiking we organize the gangs so as to skip the number of ties to correspond to number of men engaged, so as to avoid loss of time moving around or passing each other.

Putting in ties would be difficult to regulate, the nature of ballast making a great deal of difference as regards progress. It also requires less time to put in ties, where they go in a short space or distance, than where required over longer stretches of track; in other words, one could put in more ties and with less labor, in fine gravel, burnt ballast, sand, etc., and where renewals are heavy, than in rock or coarse ballast of concrete nature, etc. Where renewals are so light as to cover considerable ground there is a loss of time, carrying tools and walking. Also, in tie renewing, piece work would create a tendency to slight the quality of work, on account of pay for quantity.

It would require a good deal of time and study to work out piece work successfully to apply to track work. One of the great obstacles would be the great difference in laborers. As it is now, we have to put up with the bad or inferior as against the good, in order to keep them, for they are nearly all foreigners and related; if one attempted to get rid of or weed out the poor ones the good would also quit.

But piece work would be the thing, and a great many different classes of track work could be concluded successfully where labor conditions are not such as herein described.

PIECE WORK.

D. O'Hern, Roadmaster.

I have never had any experience in doing piece work and I do not think that piece work would be practical as a whole in the maintenance of way department. The only piece work I have seen handled has been mowing right of way, paying so much per mile to outsiders, which was practically a contract.

My opinion would be that we could not handle piece work in track laying or renewing ties; in the first place there would be a disadvantage to any one taking piece work in any kind of track work, such as laying rail, renewing ties, or ballasting, as it would put us to more or less trouble to furnish cars for the men or transportation to take them to and from work.

Furthermore, we would have to have an inspector to watch piece work, to see that it was done to standard. Paying such a man $75 per month and expenses would place the company at a disadvantage. We have foremen that understand their work and we could lay track as cheap if not cheaper, and the foremen will do their own inspecting, as we would hold them responsible for same.

I do not think that we could apply piece work to any advantage in the maintenance of way department.

GOOD LABORERS VS. PIECE WORK.

By a Canadian Roadmaster.

In regard to repairs and maintenance of track being done by piece work, or contract, I am strongly of the opinion that it would not be successful; especially in actual track surfacing, track laying, switch work, maintenance of bridges and buildings, and general care of roadbed. But the cleaning of right of way, ditching and new fencing might be done by contract with good results under careful inspection.

It appears to me that there is another side to this subject which may appear to some to be foreign, but which, to my mind, cannot be separated from it and which, in the first place, has led up to it. And that is the difficulty of obtaining good practical track men who will remain in the employ until time and experience makes their services valuable and economical to the management. The great disadvantage in the track department on most roads at the present time is cheap labor, which in the end is expensive. A competent trackman should not be classed as common laborer but as a mechanic. There is no department in the railway service that requires more intelligence and resourcefulness in its men than the maintenance of way department. And there will be an improvement as soon as the high officials of railways recognize the fact that a trackman requires at least as much education and intelligence as a brakeman or fireman. Their services are just as important for on their skill and faithfulness the whole foundation rests, and on them depend the lives of the trainmen and enginemen as well as that of the great traveling public; if the foundation is laid by cheap and unskilled men it is folly to expect the superstructure to be thoroughly safe.

The intelligent trackman should receive as liberal remuneration as the brakeman or fireman. Then you will retain in the service men who will be both valuable and efficient.

A man who has any ambition or ability will not remain long on track work for the present wage; therefore it is not the survival of the fittest, but the contrary. The illiterates and unfit ones remain and from these you have to select your future foremen. The soil is poor and the fruit will be poor accordingly.

In conclusion I may say that what I have seen of contract work on track maintenance was not satisfactory, for in most cases after the contract was finished by the contractor the regular trackmen had to go all over the work again to bring it up to standard.

PIECE WORK SYSTEM IN SUMMER.

Warren Peachey, Supervisor.

I have never used piece work in track construction or maintenance, although I believe a piece work plan could be worked out which would be beneficial to the railways for putting in ties, cutting track grass and right of way weeds, and laying new track.

Ties could be renewed for 10 cents a piece in gravel, cinders or dirt ballast. As a rule we figure on 10 ties to the man per day but if men were putting them in for so much per tie they would put in many more. I would be in favor of paying by the tie.

I believe a practical piece work system could be worked out for a great many of the different kinds of section work, such as putting in ties, laying rails and ballasting, but I do not believe piece work could be applied to section work as a whole.

When the foreman starts out in the morning to go over his section, more especially in winter, while the gangs are small, he will probably do twenty-five or thirty different jobs during the day—put on angle bars, tighten bolts, clean crossings, etc. Such work could not be classed as piece work. But in summer when the gangs work all day on one kind of work, piece work could be used.

However, I believe it would be very difficult to convince railway companies that it would be a good thing, as they figure and allow a certain amount of money for maintenance for each month. They allow each division a certain number of men or money, and when this is gone the men must be laid off, if it is not the end of the month, so as to keep within the allowance. This system would be the greatest drawback to applying piece work to section work as a whole.

HANDLING SEEPAGE THROUGH OR UNDER FILLS.

S. Cheatham, Roadmaster.

Making inspections to discover evidence of weakness or danger of washouts should be made by men patroling on foot the track that is being threatened by the high water.

In places liable to wash out, the bank should be well watched and any seeps or sand boils at foot of levee should be protected with sacks filled with sand or clay. My experience in the best protection in this line is to use the sacks and build a well of sacks around the seepage, making a drain to the well to allow the water to run away, and not to try to stop the seepage by placing the sacks of sand on the top of the place where the seepage is coming through.

Conditions which cause very high water in particular localities are heavy rains, snow melting in the mountains, and confining the rivers to too narrow channels by building levees.

To hold submerged track in place, keep it well filled in the center with crushed rock, building a levee out of sand bags or a bulkhead with timber on the lower side of the track so as the water rises it will form an eddy over the track and pour over the bulkhead or the levee of sand bags. In this way it will not damage the track.

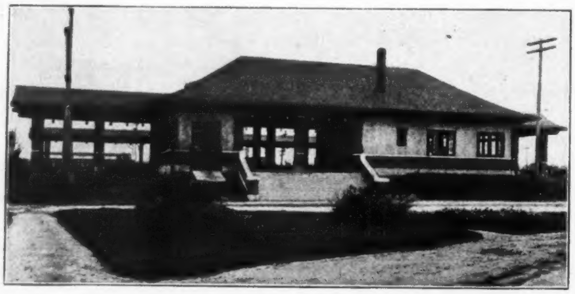
Make repairs to track after water has subsided by cribbing with timber, driving and building temporary bridges in places where the roadbed has gone in places. Cut the track down where it has not been washed out, and use just enough material to level up the track so you can get the trains over.

The method used to get across or around bridges where approaches have been washed away will depend largely upon conditions, but in most cases you will be compelled to drive piles, building bridges across those places, or building bridge approaches, where your equipment is not too heavy.

FLOSSMOOR DEPOT, I. C. R. R.

The Flossmoor depot of the Illinois Central R. R. is a very attractive type of station which has been used by this road in a number of instances, for small stations.

Flossmoor is a suburb about 26 miles from Chicago on the main line of the Illinois Central R. R. In 1911 the railway began work on the depot, which it was desired to make as attractive as possible. Near it is located an exclusive country club and golf grounds, which fact greatly adds to the regular passenger traffic.



General View, Flossmoor Depot.

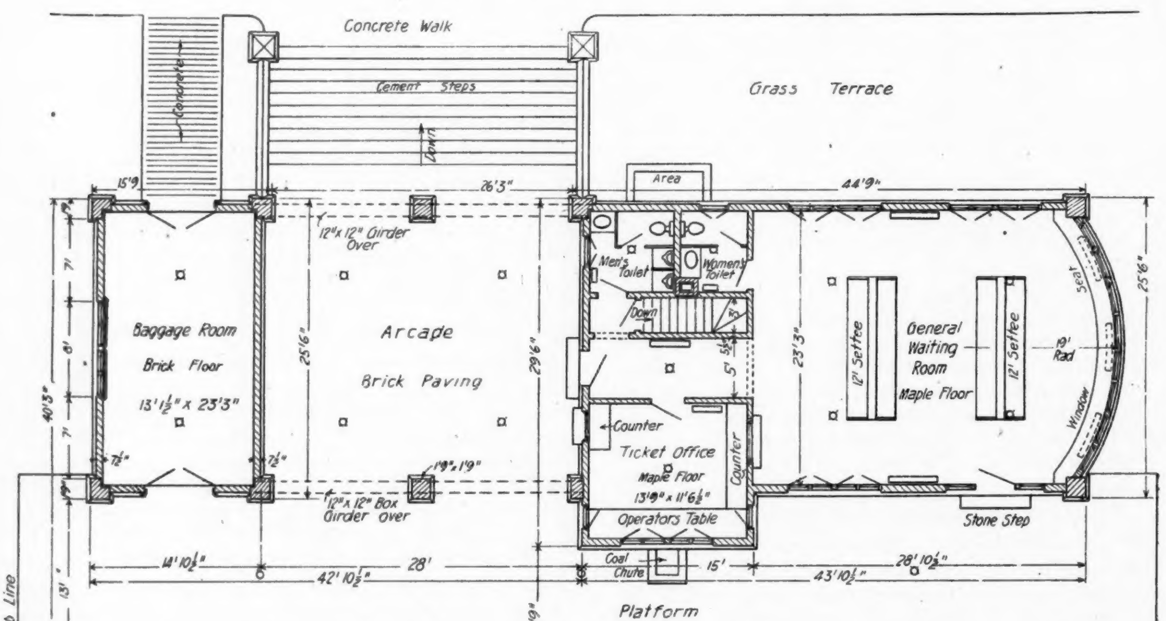
The depot is of brick construction with white limestone trimmings, which contrast well with the dark red rough surfaced brick. The roof is of red tile flared at the eaves, giving the structure a Japanese appearance though, of course, the style is not true owing to the materials used. The circular full glass bay at the south end of the waiting room gives a conservatory effect and provides a pleasing outlook. All the accommodations for the public are well proportioned and conveniently arranged.

The roof is designed to project over the platform immediately in front of the depot, in such a way that the platform extension becomes a shed and fits in architecturally with umbrella sheds when constructed.

There is a growing demand all over the country for shed protection over platforms, and while the cost of the sheds is too great to justify their use at all stations, a depot of this type gives shed protection for at least the length of the depot, and, in addition, as shown by the photograph and the plans, is adapted to the extension of sheds if built in the future.

End View Showing Shelter Shed, Part of Main Building.

It was decided to construct a subway in Illinois street at the south line of the Railroad Company's tract, to provide a crossing under its tracks to connect the east and west portions of the town. This subway provides two seventeen-foot driveways and one eight-foot sidewalk on the north or depot side. The subway is of reinforced concrete construction, providing a noiseless ballast floor bridge for the passage of trains. The

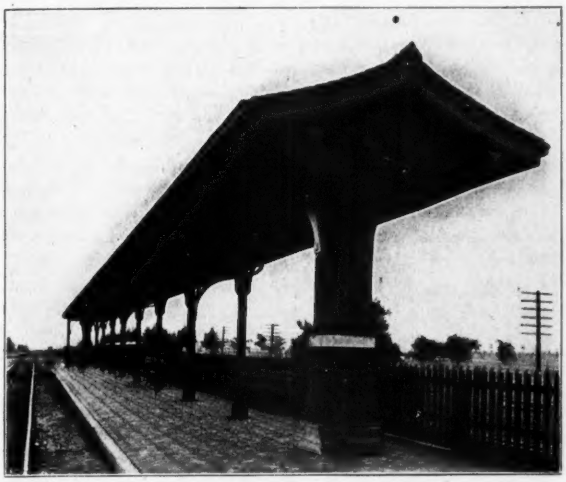


Floor Plan, Flossmoor Depot.

columns and cross girders supporting the track floor are of concrete shaped with steel forms purchased especially for this work. The columns themselves are eighteen inches in diameter reinforced with spiral steel core.

The depot was designed to harmonize, in architectural features, with the subways constructed at that point, and the south side of the waiting room was made entirely of window lights so as to afford an attractive view, this end of the building being the arc of a circle.

The design of the shelter shed in front of the depot building, shown in one of the illustrations, is worthy of special attention.



Shelter Shed Between Tracks.

The massive brick piers and the slightly concave roof, gives a very attractive appearance to the structure.

The shelter shed between tracks is modeled along the same lines as that directly in front of the depot building. The roof is supported on cast iron columns 6 ins. in diameter. The end columns, however, are of brick, which gives the shed a more substantial and sturdy appearance when viewed from the end.

The main waiting room is exceedingly well lighted, many windows being provided, as shown in the plan herewith. The room contains two massive double backed settees, placed near the center, giving an abundance of space on all sides.

We are indebted to A. S. Baldwin, chief engineer, and to D. J. Brumley, engineer maintenance of way of the Illinois Central R. R., for the illustrations and information from which the foregoing description was prepared.

A PECULIAR SLIDE.

H. H. Smith.

Your April issue requested contributions on the subject of washouts. In an experience covering more than a dozen years, I have, of course, had numbers of washouts, one in fact that was of such vast proportions that the location had to be abandoned and a new line built for about half a mile. None of them, however, presented the interesting problems that a slide did, of which I am giving you a description. I trust that it may help some other poor devil, who has had to sit up (as I had to) with such a place day after day, and night after night, and see his work slowly and surely leaving him without any visible cause.

I have always considered the experience I had with this slide as more or less unique, and it gave me more constant trouble than a number of washouts. I have had, of course, washouts that did more damage and delayed traffic longer at a time. This slide, however, was like a tiresome guest, in that it would come early and stay late. My troubles with it extended over a period of two years. There were weeks at a time when it was necessary to keep a gang there day and night, and when the gang could be moved for a few days it was still necessary to keep a watchman there. This place had more interesting and baffling phases than any other I have ever dealt with.

The slide was 150 ft. long. The track at that point is tangent, with a one per cent descending grade west. Going west, the track leaves a deep cut A B. From this cut the track is on embankment for half a mile. On the north side of the track is a deep ditch E F, which is about 10 ft. wide at the bottom. The old ditch line, on the south side, is shown by the line B G H, which crosses the toe of a hill, designated on sketch as J, and the slide was parallel to that ditch and about 30 ft. north of it. Between the cut A B and the hill J there is a small valley, which drains a large area, and at times a large volume of water comes down it. This water went down the south side of the track and ran through and over the ditch B G H.

The ditch D F, on the north side of the track, is at the foot of another hill which runs north-east, with a small valley between it and the track. The slope of the hill J, across which the track runs, is such that the track is on an embankment which is 3 ft. high on the south side and 8 ft. high on the north side. For several years prior to the time I took charge of the district and for a year afterward there was no trouble at that point. A few hours after an unprecedented rain, this place went out of line and surface, the track going down about three feet on the north side and about one foot on the south side. The material there was soon used up raising the track, but it still settled faster than we could raise it. In fact, before it could be brought to a surface that would permit the passage of trains at all, the part behind the gang would settle. The settling was so rapid that I soon used up all the material available there. I had, however, quite a supply of ties and lumber, and had to resort to cribbing. We worked from west to east. No rain had fallen for twenty-four hours, or longer, yet the settling continued so fast that thirty men could not keep ahead

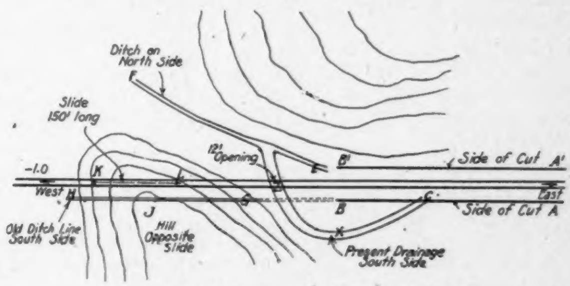


Diagram of Conditions at Troublesome Slide.

of it. This continued for ten hours, and at no time was the track more than three feet below grade, and the south side of the track was practically stationary. There were several trains on each side, and after each one passed the cribbing had to be readjusted, it having moved, too.

I then began to haul in sand. The color of some of this sand finally gave me the key to the situation. I hauled about 3,000 yards of sand there that season. The soil at that place was prairie soil. I noticed that the ground below the slide was heaving. Investigation showed that it was breaking opposite the slide and that the ditch E F was being closed up by the movement of the dirt. I also found some old piles that had once been driven at the foot of the slide to hold it. They were then about 75 feet from the track. It soon became necessary to use some of the earth at the foot of the fill, which I took to be prairie, but found to be sand and gravel. In casting this back, some of the peculiarly colored sand was found in it. This, and the fact that the south side of the track held very well, convinced me that the embankment was on some hard, slick surface. To find a remedy I dug some trenches at right angles to the track, but before I reached that surface they

filled with water, and the earth on each side caved so that they had to be abandoned.

While this trouble was occurring, about 30 ft. of track at "Z" would sink each day, but would sink uniformly. I concluded from this that there was an underground passage for water there, and this later proved to be true. A 12-foot opening was then put at that point. The ditch on the south side of cut A B was closed at C and a ditch opened through that side of the cut, from C to X, through Z to D into dith E F. The water which came down that side of the cut and the valley between it and the hill J was carried through this opening. In excavating for the opening I found, as I had already concluded, that there was a strata of marl with a dip to the north. In this, as in all other marl deposits I had known, the top of the marl, where it came in contact with the earth, was partly decomposed, and, with the water that seeped to it, formed a slick and slimy surface which caused the earth to slide. Acting on this information, I closed the ditch B G H at G, forcing all the water east of there through the opening at Z. I then widened the ditch G H and sunk it 3 feet into the marl, so that no water could get to the slide except that which fell on the surface of the ground. My troubles with this place began about a year after I took the district, and continued for two years. The last three years of my stay on that district it gave me no more trouble.

RAIL CREEPING.

To the Editor of *Railway Engineering & Maintenance of Way:*

It is my poor opinion on the creeping of rails that the following circumstances more or less affect creep:

(1) Length of rail.

(2) Section of rail.

(3) Speed of train.

(4) Load of train.

(5) Higher gradient on single line; if the rail is of heavier section in proportion to the load that travels over it then the creep takes place in descending gradient. If the rail has much deflection under the load, then the creep takes place on ascending gradient rather than descending.

(6) On curves the outer rails travel faster at the entrance and the inner rails travel faster on leaving the curves, only due to grinding of wheels in getting advance of inner and outer respectively.

(7) Magnetizing of rails when running in direction of the poles (attracted toward poles).

(8) Number of ties in a rail.

(9) The area of the rails and ties covered, with nature and kind of ballast, i. e., that which absorbs shock and retains moisture to lower the outward temperature.

(10) The fastenings gripping the rails.

(11) High or low banks or cuttings.

(12) Line passing through thick forest.

(13) Numbers of level crossings.

(14) Number and length of bridges (camber and elasticity of girders on bridges).

(15) Condition in up-keep of the road.

(16) Elasticity of road bed.

(17) Direction, pressure and degree of hot winds.

(18) Fishing angles.

(19) Tightness of the bolts of fish plates.

(20) Expansion distance allowed between two ends of rails.

(21) Greater traffic running, whether on cold or hotter part of the day.

(22) Length of bearing area and distance ties are apart.

(23) Description and kind of ballast on which depends the distribution of the weight on greater area, and the effect of weather or different temperatures.

I need not describe in detail the phenomena of the state of the road when the load is passing over it, for a wave-like motion is preceding every wheel of the load, in more or less degree, according to its up-keep. Spring of ties, section of rails, and the proportion of load to which the rail is subjected; anchorage ties in ballast in proportion to length and depth; friction of bearing area; grip of fastening and the temperature at the time of load traveling, etc., all have their effect.

The creep generally starts at the change of the weather, i. e., cold to hot, summer to winter, etc.

There is a successful device adapted to suit the Indian climate for D. H. B. H. rails. These are steel spring keys named anti-creep keys by W. H. Wolff, the late chief engineer of this railway.

Further, the creep can be prevented in more or less degree, rectifying the above evils, by using stronger section of rail, uniform spacing of ties so as not to give spring in rail, tightening of all fittings with moderate tightening of fish bolts, improving the fishing angle, and lubricating them so as to give least frictional area with the rail and cause it freely to expand or contract easily without displacement of fish bolts, and fully covering the rails and fittings with the ballast so as to give only flange clearance from top of rail head, i. e., 1½" from the top between rails; this is only that the outer temperature may not affect the rail and fastenings, and to give a good anchorage of sleepers, and friction with the rails and fittings.

(Signed) Sorabji, D. R., Permanent Way Inspector,
B. B. & C. I. Ry.,
Viramgam, India.

MAINTENANCE BY REGULAR SECTION FORCES VS. EXTRA GANGS.

By Westerner.

In considering maintenance work done entirely by regular section forces, as compared with maintenance work by section forces occasionally assisted by extra gangs, let us consider the proposition first under ordinary conditions where it is necessary to do only a limited amount of renewals, those that will not be general. Both for efficiency and low cost, it is well to do the work with section forces.

By increasing forces or doubling two crews together it would be well to handle all short sections of relaying and reballasting with the section forces. It is possible with larger section gangs to make extensive renewals of ties, to put in switches and to lay short extensions, or new sidings, as most section foremen are capable to this extent. In the case of a new or young foreman not up to standard, sending his well schooled neighbor to assist is doubly beneficial and excellent results are usually obtained.

However, we occasionally find a section foreman altogether incapable of handling more than 4 to 6 men. I have noticed several cases where foreman with four to six men did excellent work, but with 8 to 14 men he could not nearly double his work. While another foreman would do more than double work with double force. I will take that feature up more fully later and attempt to give the actual cause.

General Renewals Handled by Section Forces.—Say an entire division is to be relaid, resurfaced, ties spaced and renewed, and track reballasted. There could be two plans followed, as I see it. First, give each section foreman sufficient men to handle his own work. We would have here a gang relaying every five miles, which, even under light traffic conditions, would cause considerable delay. Again, we would encounter the inexperienced foreman and loose efficiency, and by the time such foremen had received proper education along these lines, the cost would overbalance effectiveness. At the same time, should they relay the entire section before spacing and anchoring joints, the expansion would become bunched, giving considerable future annoyance.

It is best to keep this back work as close as possible to relaying and endeavor to maintain expansion in each rail as nearly according to specification as possible. This takes a considerable force and is more than the ordinary section foreman could do. If he relays one whole day, it would require nearly three days to properly do the back work, thus making very

slow progress, and I believe the ultimate cost would be entirely too high.

Another organization of section forces might be made to do this work. By beginning at either end, and doubling the first two gangs, let them relay to the point where it would be more profitable to bring in the third section. Turn the first man back to bring up the reballasting, spacing, etc., and so on to end of division. Here we would lose the efficiency gained by the trained foreman and men of the first section, and pick up another incomplete organization of untrained men on third section, and at each succeeding section. This would give us inefficient results throughout. However, this method may be applied and the organization carried out effectively on a heavy traffic line, where it would be necessary to keep traffic moving on schedule, where the main line could only be torn up for a few minutes at a time. In fact, I believe it would be equally as good or a better plan as to organize a small extra gang.

A third system would be to organize a small extra gang for the relaying and follow up with section gangs. The choice between these methods would be controlled by competency of the foremen together with class of work behind relaying. In some cases the latter might be very light and easily handled by section forces.

Extra Gangs for General Renewals.—On comparatively light traffic lines, I would prefer reducing section forces to a minimum, for ordinary up-keep, and would organize extra gangs for the entire job. In this case, with a good foreman in each gang with able assistants, we would have full efficiency of trained men throughout, and the work would be more uniform. Reballasting, spacing, etc., could be kept up close enough to retain the rail as desired. This is considering the labor on sections and extra gangs to be equally good. Where the labor on both sections and extra gangs is of the same class, the efficiency of the work depends entirely on the ability of foremen. If there is any trouble in keeping men, I believe the extra gang will be found in favor, as there is a kind of fascination for men in large gangs.

I will now attempt to give causes for inefficient work in both extra section gangs. This applies principally to extra gangs, however, as sections gangs are usually too small to be affected in a general way.

A foreman, to be a success, should be a fair judge of human nature, pleasant and honest with his men, and at the same time just, exacting, and strict in discipline. He should continually study the temperament of his men individually, place them in positions so that each has plenty of room and, if possible, far enough apart to keep down conversations and visiting. He should watch for talent, and place each man according to his talent. It will be found that some are excellent finishers, but wholly useless as effective tampers and spikers. Others may be unfit for either and be good at handling ballast or dirt with a fork or shovel. Others are more suited for clawbars, spiking, or tie handling.

The foreman that carries this idea out successfully has an organization 100 per cent efficient. His men are all suited for their respective tasks, turn their work out in a neat manner and are speedy. The foreman has no worry and each morning his men will organize themselves and the work will progress in harmony.

On the other hand there is occasionally a foreman who starts in, in a bulldog manner, and tells his men to "grab a tool of some kind and get busy." He will find a man not tamping thoroughly and either abuse or discharge him when it is not in the man and he would never be a thorough, quick tamper. He will of course do the same thing with the poor spiker, finisher, etc. There results a continual hubbub, disorganization. He has continual worry and is eternally bawling at the men. At night he looks back over his work, sees this and that incorrectly done, no indication of a standard, and goes to camp mad with himself, his men, and the world.

There are as many different types of foremen as there are individuals. To obtain a good extra gang foreman, the roadmaster should watch his section foremen exactly as a foreman should his men. And when he finds a man that is always a little ahead of his work, talented, keeps his track in good condition, and yards and premises in a neat, clean condition, he should by some means begin schooling the man, giving him hard pieces of work with a few more men, or in any other practicable manner, i. e., he should give him, first, an opportunity to lead out. You will sometimes be mistaken, but not as a rule. It is much easier, though, to obtain successful section foremen than extra gang foremen and I believe it is to some extent caused by negligence of roadmasters in coaching and educating men when an opportunity presents itself.

COMBINED ORGANIZATION.

P. H. Hamilton.

There has been a great deal said, recently, about economies in operation and new methods of reducing maintenance costs, a great many innovators mentioning the necessity for an increase in wages. I believe that the departmental operation of the maintenance of way department has resulted in many a dollar being spent from which no returns were received. No one ever dares to step beyond the limits of his department, as he would not only be establishing a precedent, but the head of the other department whom he was possibly endeavoring to assist would consider it a personal affront.

The vocational organization of the division forces is responsible for: the roadmaster being interested in the success of the railroad only as far as the track is concerned; the general foreman of bridges and buildings, the foreman of water service, and the supervisor of signals, being interested only so far as their departments are concerned. As a result, they rarely work together, and often work against each other. The result is that they have acquired an educated egoism for their individual departments; and no small amount of sermons or entreaties can convert them.

On some roads the mechanical department, as far as the operation is concerned, is under the division superintendent, as is every other operating and maintenance sub-department; and in nearly every case this organization has proven a success. The bridge, building, water service, track, and signal departments are closely related in their work; and they should work together. They should all report to one man, the division superintendent, who is always close at hand, and who can take quick action on any question that may arise, and who is in position to act as a mediator and can reduce "red tape." These departments should work together in an effort to reduce the cost of maintenance; and they should work for the mutual interest of each other. There are numerous instances where money is squandered away—sometimes large amounts, and sometimes small amounts—on account of this vocational organization. I have seen water-service men going 100 miles to repair a pipe line in a roundhouse at a cost of probably $5.00, when the roundhouse force could have done the work for $0.50. I have seen a carpenter gang of all high-priced men moving oil storage tanks, where less skilled men could have done it just as quickly. I have seen $2.50 per day men digging a ditch for a water line when $1.70 per day men could have turned out as much work.

A section foreman, or an average native trackman, can place a glass in a station sash; he can repair a freight platform, or a brick station platform or sidewalk. He can repair a stock yard; and he can do numerous other emergency jobs that bridge and building men are sometimes sent long distances to do, and he can do it at a minimum cost. The section gang can line a bridge, or place a cap or a stringer, under the supervision of the bridge inspector, and they can be of assistance in other ways. These small repair jobs are what eat up a maintenance allowance, especially where transient men are concerned, as there are many hours of dead time turned in on account of going from one small job to another, and on account of waiting for or on trains. The skilled bridge, building and water service men are now doing a great deal of work where only semi-skilled

labor is necessary, on account of the vocational organization.

By furnishing each bridge inspector with a motor car, he would be able to get over the average division in two weeks; and, as an inspection is necessary only once a month, he could spend the other two weeks in taking care of the minor repairs, with the assistance of the section gangs. He would probably put in a day, or a fraction of a day, here and there, with the various section gangs; and he would be able to take care of a great number of necessary small jobs at a minimum cost. This would permit the bridge gang to put in all of its time on heavy repairs, or they could follow the light repairs along in systematic order, and we would get "value received."

The objection comes up that the trackmen are already overburdened—and it is true. But, if more work is to be done by them, they will assuredly get more help. There has been much said about increasing the efficiency of the trackman; and it sems to me that by widening the scope of his duties we are laying the foundation for this much desired quality. If he can produce an increase in efficiency, he can command better wages. Better wages will attract more efficient men, and will do more to lighten his burden than any other combination of conditions.

Another objection comes up. There may be more or less friction, or misunderstandings, as a result of this kind of an organization. This would depend entirely on the personalities of the roadmaster, the general foreman of bridges and buildings, the water service foreman, the supervisor of signals, and the master mechanic. If any one of them was filled with selfishness for his department, he might cause a small amount of friction; but the superintendent would always be at the head to straighten these matters out. The heads of the bridge, building and maintenance of way departments should be placed in closer touch with the superintendent, and they should be considered part of his staff, working together and having always the interests of the company foremost. And, being in closer touch with each other, they can assist each other in reducing the cost of maintenance. By reducing the cost of maintenance, per unit, we can accomplish much more work with our allowances.

We now have pumpers repairing cars, cleaning coaches, inspecting interchange cars, etc. We have section men assisting the linemen, and the signalmen. We have them unloading coal, etc. We have joint agencies. It appears to me that we can carry this idea further with gratifying results.

The roadmaster and the general foreman should be relieved of about nine-tenths of the clerical work that is being forced upon them, and they should be free to spend the greater part of their time with their men. I do not think that they should have an office, other than a desk in the superintendent's office. All reports and detail work of a clerical nature should be handled by the superintendent's office; all routine reports from the foreman should go direct to the superintendent's office; and all written instructions should be issued from the superintendent's office to the foremen. All correspondence with direct reference to the work should be handled by the roadmaster, or the general foreman, through the superintendent's office. It would not be necessary for them to each have a personal clerk, but there would be one stenographer in the superintendent's office designated to handle their personal correspondence, their files being combined with the superintendent's. What force they now have would be incorporated with the superintendent's office force. The accountant, or some other competent clerk, would have charge of the clerical end of the maintenance of way work, and should be able to cut out a great portion of the useless repetition of work. This office organization would, I believe, also tend to shorten up "red tape," would result in a saving of time, and would result in other great increases in office efficiency.

The Southern Pacific officials and authorities of Houston, Tex., have conferred with reference to a viaduct to be built over the railroad's tracks at Maury, Elysian and Hardy streets in Houston.

Personals

R. York has been appointed roadmaster of the Algoma Central & Hudson Bay Ry. at Michipicoten Harbor, Ont., succeeding J. Guthrie.

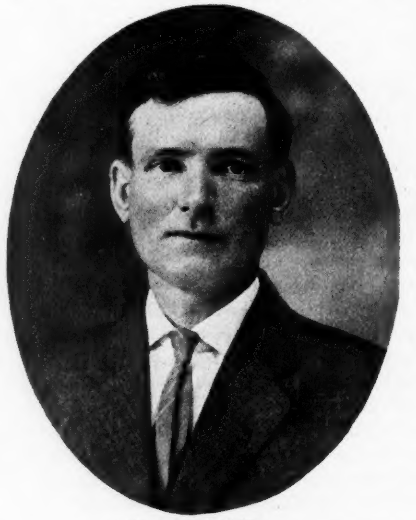
E. B. Dehart has been appointed roadmaster of the Atchison, Topeka & Santa Fe Ry. at Pueblo, Colo.

Richard Berryman, roadmaster of the Bangor & Aroostook R. R., has been transferred from Van Buren to Fort Kent, Me. Charles Tweedie, roadmaster, has been transferred from N. Maine Jct., to Millinocket, Me. R. Wibberly, roadmaster, has been transferred from Houlton to Presque Isle, Me. The above appointments were effective June 1.

W. Murphy has been appointed assistant roadmaster of the Canadian Northern Ontario Ry. at Sudbury, Ont., succeeding A. E. Reid.

Wm. Bibby has been appointed assistant general roadmaster of the Central Vermont Ry., office at St. Albans, Vt.

C. Starks has been appointed roadmaster of the Chicago, Burlington & Quincy R. R. at St. Joseph, Mo., succeeding John Bosch.



H. W. SCOTT,
Roadmaster Lorain, Ashland & Southern R. R.

H. O. Sinsabaugh has been appointed roadmaster of the Chicago, Rock Island & Pacific Ry. at Goodland, Kan. E. T. Thomas has been appointed roadmaster at Fairbury, Neb., succeeding P. L. Daugherty.

N. Noailles has been appointed roadmaster of the Cumberland Ry. & Coal Co., at Glace Bay, N. S.

J. H. Bowen has been appointed roadmaster of the Denver & Rio Grande R. R. at Salt Lake City, Utah.

O. G. Horton has been appointed roadmaster of the El Paso & Southwestern System at Tucson, Ariz.

L. Muller has been appointed roadmaster of the Ferdinand R. R., at Ferdinand, Ind.

F. Franzau, supervisor of track of the Grand Trunk Ry., has been transferred from Durand to Port Huron, Mich.

G. Carlson, assistant roadmaster of the Great Northern Ry., has been transferred from Elizabeth to Pelican Rapids, Minn. J. O. Danielson has been appointed assistant roadmaster at St. Cloud, Minn., succeeding J. Kiloran. O. Erickson has been appointed assistant roadmaster at Breckenridge, Minn., succeeding F. J. Ellis. W. F. Hart, formerly roadmaster on the A. T. & S. F. Ry., has been appointed assistant roadmaster at Essex, Mont., succeeding A. Brittenham. C. Johnson has been appointed assistant roadmaster at Whitefish, Mont., succeeding Jas. Lukoskie, transferred to Devils Lake, N. D. Jos. Stralka has been appointed assistant roadmaster at Kelly Lake, Minn.

R. L. Webb has been appointed supervisor of the Illinois Central R. R. at Durant, Miss., succeeding J. W. Welling.

Geo. Cooper has been appointed acting roadmaster of the Intercolonial Ry. of Canada at Moncton, N. B.

W. Muhe has been appointed roadmaster of the International Rys. of Central America, succeeding E. Morris.

R. E. Hollister, supervisor of the Long Island R. R., has been transferred from E. New York to Jamaica, N. Y.

H. W. Scott, who has been appointed roadmaster of the Lorain Ashland & Southern Ry. as announced in the June issue of *Railway Engineering*, began railway work in December, 1898, with a construction gang on the Ashland & Wooster Ry., and in October, 1899, was employed as section hand. In 1902 he was appointed section foreman, and in March, 1905, was appointed roadmaster. He held that position with this railway and its successor, the Ashland & Western Ry., until June 13, 1913, when he was appointed roadmaster at Jeromeville, O., as mentioned above.

G. H. Hooper has been appointed roadmaster of the Louisiana Ry. & Navigation Co. at Alexandria, La., succeeding Robert Smyth.

H. L. Galloway has been appointed roadmaster of the Mississippi Central R. R., at Hattiesburg, Miss., succeeding S. W. Brook, deceased.

Wm. Stiles has been appointed roadmaster of the Missouri, Kansas & Texas Ry. at Atoka, Okla.

H. E. Astley, formerly roadmaster, has been appointed track supervisor of the New York, New Haven & Hartford R. R., at Boston, Mass. D. J. Brennan has been appointed track supervisor at Willimantic, Conn. M. P. Condon, formerly roadmaster, has been appointed track supervisor at Providence, R. I. G. A. De More, formerly roadmaster, has been appointed track supervisor at New Haven, Conn. P. Dougherty has been appointed track supervisor at Sanford, Conn. J. P. Hurlihe has been appointed track supervisor at Willimantic, Conn. Jerry Murphy has been appointed track supervisor at Hyannis, Mass. John Robertson has been appointed track supervisor at Providence, R. I. C. H. Rogers has been appointed track supervisor at Taunton, Mass. John Savage, track supervisor, has been transferred from Boston to Franklin, Mass. J. H. Smith, formerly roadmaster, has been appointed track supervisor at Waterbury, Conn.

P. K. Lutken has been appointed roadmaster of the New Orleans, Mobile & Chicago R. R. at Laurel, Mass., succeeding H. L. Barfield.

R. F. Tavenor has been appointed roadmaster of the Norfolk & Western Ry. at Jaeger, W. Va., succeeding B. P. Willis.

P. E. Anderson has been appointed roadmaster of the Northern Pacific Ry. at Walla Walla, Wash., succeeding J. G. Cutler, deceased. G. C. Chittenden has been appointed roadmaster at Pasco, Wash. succeeding C. C. Blood, transferred. P. McGuire has been appointed assistant roadmaster at Staples, Minn. Joseph Smith has been appointed roadmaster at Brainerd, Minn.

E. A. Warren, formerly roadmaster of the Southern Kansas of Texas, has been appointed roadmaster of the Pecos & Northern Texas Ry. at Amarillo, Tex.

H. C. Bolenius has been appointed supervisor of the Pennsylvania R. R. at Conemaugh, Pa., succeeding W. T. Hanly, transferred to Newport, Pa. M. W. Clement has been appointed supervisor at New York, N. Y. F. D. Davis has been appointed supervisor at Barnesboro, Pa., succeeding R. R. Nace, transferred to Buffalo, N. Y. Frederick Evans has been appointed supervisor at Sunbury, Pa. J. O. Hackenberg has been appointed supervisor at East Liberty, Pa. J. C. Smith has been appointed supervisor at Bedford, Pa., succeeding M. de K. Smith, transferred to W. Brownsville Jct., Pa., in place of B. O. Hultgren. E. O. Wood, supervisor, has been transferred from Sunbury, Pa., to Trenton, N. J., succeeding R. Faries.

J. Healy, roadmaster of the St. Louis & San Francisco R. R., has been transferred from Enid to Antlers, Okla., succeeding N. H. Kruse, transferred to Enid, Okla. J. J. Phayer has been appointed roadmaster at Cape Girardeau, Mo., succeeding C. S. Kirkpatrick.

J. N. BAKER,
Roadmaster Tremont & Gulf Ry.

J. O. Drake has been appointed roadmaster of the San Antonio & Aransas Pass Ry. at Cameron, Tex., succeeding J. P. Hopkins.

W. L. Stanton has been appointed roadmaster of the Scott City Northern R. R. at Scott City, Kan., succeeding H. C. Clubb.

C. W. Anderson has been appointed roadmaster of the Southern Ry. at Greensboro, N. C., succeeding T. B. Sumner.

F. B. Hart, formerly roadmaster of the Pecos & Northern Texas Ry., has been appointed roadmaster of the Southern Kansas Ry. of Texas at Canadian, Tex., succeeding E. A. Warren.

J. N. Baker has been appointed roadmaster of the Tremont & Gulf Ry. at Winnfield, La., succeeding R. L. Ray.

With The Manufacturers

TRACK SUPPLY ASSOCIATION.

The Track Supply Association will hold its annual exhibit in connection with the convention of the Roadmasters and Maintenance of Way Association, at the Auditorium Hotel, Chicago, Ill., on September 9-12, 1913, in conjunction with the thirty-first annual convention of the Roadmasters and Maintenance of Way Association.

This announcement will be of great interest to all those who attended the last year's Convention, and who were recipients of the lavish entertainment of the Track Supply Association at Buffalo.

The Ladies' Auxiliary will undoubtedly be interested in this announcement also, for there was scarcely a minute of any day that the Track Supply Association did not have something doing for them. The entertainment this year, for both the members of the Roadmasters' Association and the Auxiliary, will be fully up to standard and will probably surpass previous efforts.

A large number of firms have already obtained exhibit spaces. Assurances have been received from about twenty prominent supply concerns, not mentioned, that they will send in applications in the near future. The value of the exhibit to both supply dealers and roadmasters cannot be overestimated.

Among those who will exhibit are the following:

Ramapo Iron Works.
The P & M Co.
The Rail Joint Co.
Lackawanna Steel Co.
Fairbanks-Morse Co.
Pennsylvania Steel Co.
National Lock Washer Co.
Elliott Frog & Switch Co.
The Railway Equipment & Publication Co.
Associated Manufacturers Co.
American Hoist & Derrick Co.
Fairmont Machine Co.
The Joyce-Cridland Co.
Louis Blessing.
James C. Barr.
Q & C Co.
M. W. Supply Co.
The American Guard Rail Fastener Co.
Crerar, Adams & Co.
Templeton, Kenly & Co., Ltd.
Indianapolis Switch & Frog Co.
Union Switch & Signal Co.
Hayes Track Appliance Co.
The Railway List Co.
Railway Engineering and Maintenance of Way.
Verona Tool Works.
The National Malleable Castings Co.
Haggard & Marcusson Co.
Positive Rail Anchor Co.
Carnegie Steel Co.
William Wharton, Jr., & Co., Inc.
Hubbard & Co.
The Hobart Allfree Co.
Hall Switch & Signal Co.
Burton W. Mudge & Co.
Southern Railway Supply Co.
The Railroad Supply Co.
Sellers Manufacturing Co.
Hall Switch & Signal Co.
Simmons-Boardman Pub. Co.
Ajax Forge Co.
American Steel & Wire Co.
Beaver Dam Mall. Iron Co.
Keystone Grinder & Mfg. Co.
Northwestern Motor Co.

Industrial Notes

F. J. Lepreau has been appointed assistant western sales manager of the primary battery department for central western territory, of Thomas A. Edison, Inc., with headquarters at 229 South Wabash avenue, Chicago, Ill.

The products of the Barber Asphalt Co., of which the Protectus Paint Co., Philadelphia, Pa., has recently taken the railway selling agency, include asphalt insulating and building papers, asphalt felts and other asphalt fabrics, asphalt roofings, asphalt waterproofing compounds and asphalt "Mastic" for floors.

W. E. Jenkinson has been made railroad representative for S. F. Bowser & Co., Inc., Fort Wayne, Ind., covering that territory vacated by E. F. G. Meisinger. In addition, he will take over the Southwestern and Pacific coast territory. He will cover the states from Texas to Oregon.

Sealed proposals, in triplicate, will be received at the office of the general purchasing officer of the Isthmian Canal Commission, Washington, D. C., until July 9, for furnishing the following supplies: Electric lamps, motor boats, switch stands, tie-plates, track bolts, track spikes, galvanized roofing, horseshoes, washers, stovepipe, iron and steel pipe, pipe fittings, lead pipe, bibbs, clean-outs, valves, chisels, cable clips, cotters, wrenches, twist drills, hammers, tacks, files, tallow pots, hand oilers, padlocks, galvanized buckets, water coolers, coal baskets, brooms, scrub brushes, paint brushes, steel tapes, hose, packing, gaskets, canvas, tarpaulins, railway flags, emery cloth, mop heads, oakum, twine, lime, calcium carbide, sulphate of copper, muriatic acid, drop-black paint, sienna, spar varnish, aluminum paint and mahogany lumber.

The Stone & Webster, Stone & Webster Engineering Corporation and Stone & Webster Management Association, First National Bank building, Chicago, Ill., make the announcement that Edward N. Lake, formerly in charge of the electrical division at Boston, will hereafter represent the Stone & Webster Engineering Corporation at Chicago, Ill.

New Literature

The Richmond Screw Anchor Co. has sent out a leaflet describing and illustrating the Thiollier Helical Lining for screw spikes. In addition, a number of other types of screw linings for screw anchors in concrete are described and illustrated.

* * *

The Industrial Works, Bay City, Mich., has recently issued Bulletin No. 209, describing wrecking locomotive, construction and freight cranes, transfer tables, and pile drivers. The section on construction cranes describes and illustrates cranes for bridge erecting, excavating buckets, magnets, and handling lumber. The general appearance of this catalogue is excellent and information given in this Bulletin is valuable.

* * *

"Toncan" is the title of a catalogue recently received, dressed in a fantastic red and silver cover. The first section of this book is termed "technical section" and contains the basis of claims—that this metal, although not proof against uniform rusting, is anti-corrosive. A number of illustrations show the uses of this metal.

* * *

The C. F. Pease Co., Chicago, has issued a very attractive and complete catalogue on blue print machinery, blue print room supplies, direct white print machinery, and drafting room furniture. On page 3 of this catalogue is shown a diagram illustrating the compactness of the Pease blue printing machinery, which gives a comprehensive idea of the same. The description of the process is clear, concise, and complete. The illustrations used amplify the text in a pleasing and instructive manner. The appearance and general makeup of this catalogue is suggestive of its purpose, as well as attractive.

* * *

Samuel Cabot, Inc., Boston, Mass., has issued a booklet describing the uses of Cabot's "Conservo" wood preservative. A description of the properties of this oil is given, explaining the reasons for its efficiency. Following this are a number of photographs of structures in which Conservo has been used, and in addition specimens of wood treated, showing penetration, etc. Enclosed in this catalogue is a leaflet illustrating and describing the historical Old Chain Bridge at Newburyport, Mass., which has been recently restored, all woodwork being treated with this preservative.

* * *

The Westinghouse Electric & Mfg. Co. has issued descriptive leaflet No. 3679, covering electric vehicle battery-charging switchboards and motor generator sets. These devices are described and illustrated in detail. Special mention is made of the sectional switchboard which enables the additions to be made to the outfit from time to time with slight expense. Folder 4255 illustrates Westinghouse type PG porcelain insulators. These insulators have high mechanical strength, suitable for use on 1500-volt D. C. railway work, and 2200-volt transmission lines.

Positions Wanted

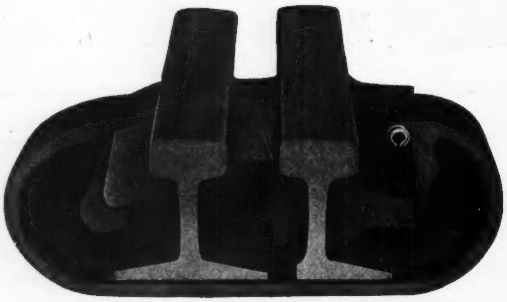
DIVISION ENGINEER on maintenance work, age 32, nine years' experience as rodman, levelman, topographer, transitman, assistant engineer, resident engineer, and division engineer of maintenance. Have had charge of river and damage claim surveys. of construction of buildings, bridges and treating plants, double tracking, and also served as superintendent of construction for large contractor. Excellent references. Address T. E. W., care of **Railway Engineering,** 431 South Dearborn street, Chicago.

INSTRUCTING FOREMAN, man of wide experience in maintenance work, desires position with railway as instructor to section foremen. Address K. F., care of **Railway Engineering.**

SECTION FOREMAN, with 7 years' experience, desires position, preferably with eastern railway. Address L. D. C., care of **Railway Engineering.**

ESTABLISHED 1882

THE WEIR FROG COMPANY



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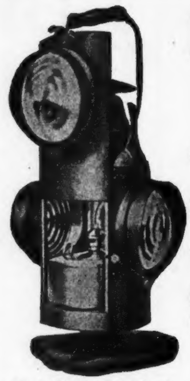

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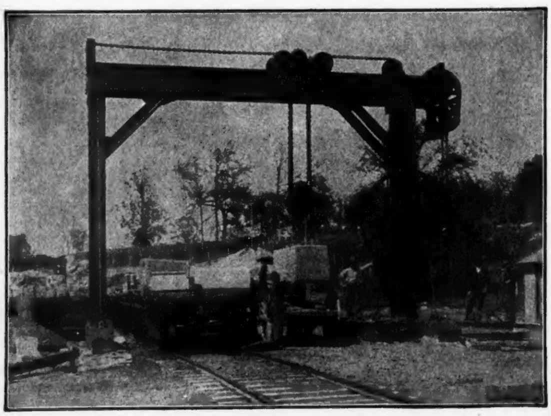

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Type C for rail up to 65 lbs.	4½ Inches high	30 Ton Locomotive	2½ Ins.	60
Type B for rail up to 80 lbs.	5 Inches high	50 Ton Locomotive	3¼ Ins.	110
Type A for rail up to 100 lbs.	5½ Inches high	80 Ton Locomotive	3½ Ins.	145
Type Z for rail up to 100 lbs.	6 Inches high	100 Ton Locomotive	3½ Ins.	165

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The word DANGER appears in white on a brilliant red oval set on a black background.

The color combination is striking—it immediately conveys a warning, and its brilliancy and sharp contrasts compel attention.

It is cheaper to install this sign than to install a wooden one; in fact it's cheaper to install a new **Universal** sign than to pay for maintaining an old wooden one. **Universal** signs will not chip, crack, rot or fade, and they are so well protected by the enamel that they will practically never rust. The colors and letters are **burned on,** and they will **stay on.** Weather and smoke does not dim the brilliancy of these signs.

Our manufacturing facilities enable us to make these signs in quantities and allow us to quote surprisingly low prices. These three considerations—the brilliancy and sharp contrasts which compel attention—the durability—and the low price—have set in motion a campaign to make the Universal the **Standard** danger sign. We will be glad to send you, without charge, a full sized print of the Universal in colors, and furnish prices.

We can also quote some very attractive figures on special enameled signs and notices for platforms, crossings, culverts, bridges, waterways, cattle passes, third rails, slow speed sections, whistle posts, yard limits and siding.

Let us figure on your requirements.

The Stonehouse Enameled Steel Sign Company

907 EIGHTEENTH STREET :: :: DENVER, COLO.

EXCAVATING BUCKET

BEST ON EARTH

Standard Bucket
Type "C" Closed

These

BUCKETS

are the

Standard Bucket
Type "D" Closed

Most Durable Buckets Made. Built Entirely of Steel

IN ALL SIZES

A BUCKET FOR EVERY SERVICE

Write

THE G. H. WILLIAMS CO.

CLEVELAND, OHIO

Single Rope Bucket
Closed View

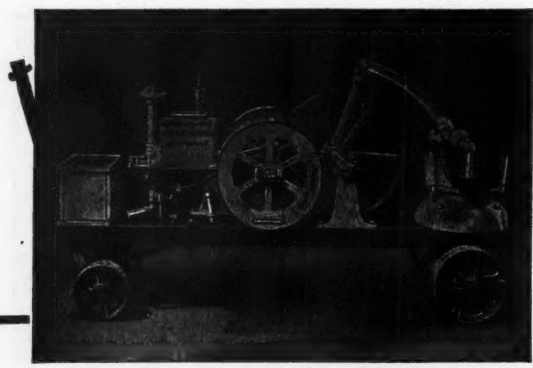
FOR

INFORMATION

and

PRICES

Single Rope Bucket
Open View

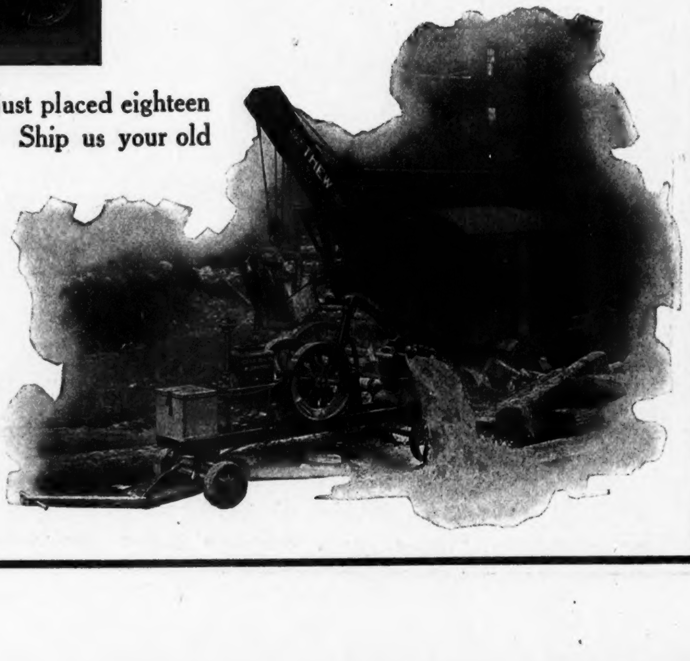


PUMPS

40 GALLONS WHILE PAT STOPS TO LIGHT HIS PIPE

Put this portable power driven diaphragm bilge trench pump on your job.

The C. M. & St. P. Ry. Co. have just placed eighteen of these Pumps on their different jobs. Ship us your old hand pumps. We will mount them for you in connection with our Power Driven outfit.



WRITE US

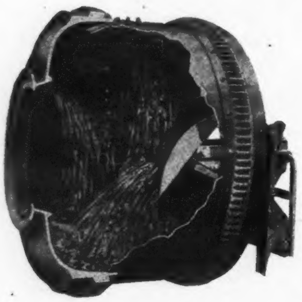
For our attractive catalog—just off the press.

C. H. & E. Manufacturing Co.
INC.

385 Mineral St. Milwaukee, Wis.

K K

Three Independent Mixing Actions



Before you recommend a Concrete Mixer, be sure you know all about

THE KOEHRING

The three independent mixing actions in the KOEHRING cause a continual intermingling of all material in the drum. This enables you to do three times as much mixing as you could with a machine enjoying only one mixing action.

Our EXTENSION LOADER feature was especially designed for railroad work.

If your superior officer asked you about the KOEHRING, would you acknowledge that you were unacquainted with its superiorities?

You can get a KOEHRING CATALOG for the asking.

KOEHRING MACHINE CO
MILWAUKEE, WISCONSIN

(COUPON)
KOEHRING MACHINE CO., Milwaukee.
Send me your full Catalog on the Koehring Mixer. I want to secure knowledge which will, perhaps, be beneficial to my success.

....
....
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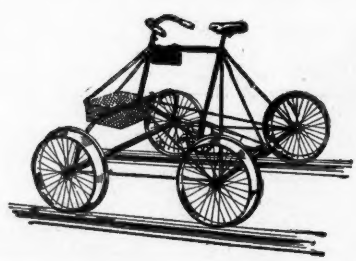
K K

HARTLEY & TEETER



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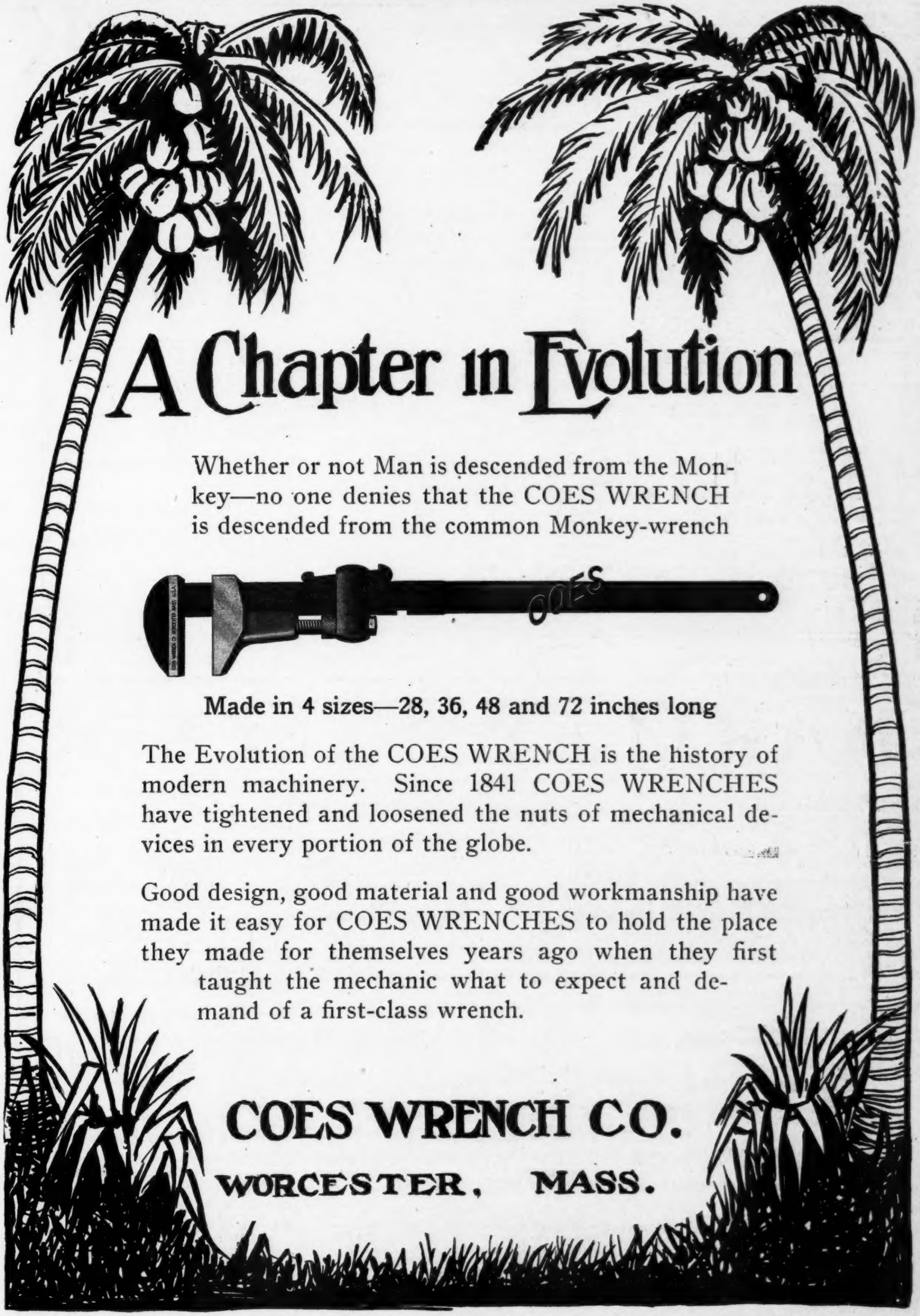
LIGHT INSPECTION CAR CO.
HAGERSTOWN, INDIANA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COES
Made in 4 sizes—28, 36, 48 and 72 inches long
The Evolution of the COES WRENCH is the history of modern machinery. Since 1841 COES WRENCHES have tightened and loosened the nuts of mechanical devices in every portion of the globe.
Good design, good material and good workmanship have made it easy for COES WRENCHES to hold the place they made for themselves years ago when they first taught the mechanic what to expect and demand of a first-class wrench.
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